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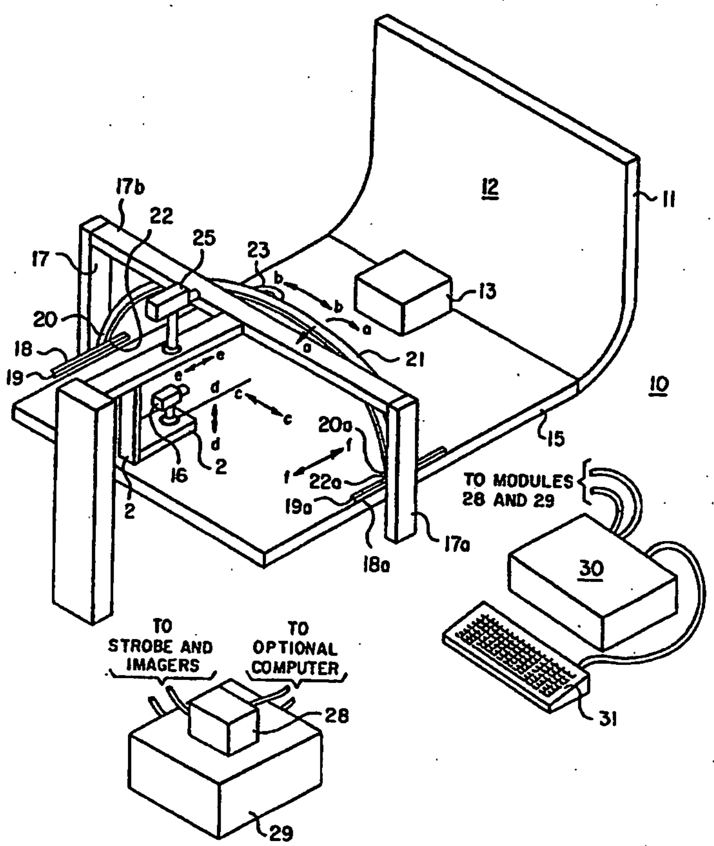
(54) Title: SEAMLESS COMPOSITE PHOTOGRAPHY SYSTEM

(57) Abstract

A system and method for versatile photography featuring seamless integration of two or more separate images into one composite image. A variety of digitally recorded background scenes are provided for selection, each scene having digitally recorded coordination criteria for automatically or manually adjusting intensity, hue, direction and other lighting parameters. Included is the capability for simultaneously recording images on conventional film (16), video media (25) and digitally imaged still photography media (16). Local subjects are exposed by strobe light (23) so as to include the background process screen (11). Synchronizing circuit (28) is included to ensure effective synchronization. One of the recording medium (25) may be employed to provide a preview immediate viewable by the subject. In the event the exposure is recorded on photographic film (16), the photographic film is subsequently scanned to produce a digital electronic recording (25) that is computer processed (30) to seamlessly and realistically integrate it into the selected background scene.



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SEAMLESS COMPOSITE PHOTOGRAPHY SYSTEM

This application is a Continuation-in-Part of United States Patent Application Serial Number 08/077,202 filed June 15, 1993 by Robert H. Shelton. It relates to Seamless Composite Photography and more particularly to apparatus, systems and methods for facilitating the practice of such photography. In accordance with the system hereof, it employs characterizing backdrops such as a process screen background in combination with photographic flash illumination controlled to exhibit predetermined characteristics.

Background of the Invention

In practicing the photographic arts, it has heretofore been proposed to produce seamless composites in which a predetermined subject is incorporated into one or more selected scenes (e.g., in motion pictures) in such a way as to appear to be original photography rather than a contrived combination. Illustrative of such prior proposals are those set forth in United States Patents 4,169,666 granted October 2, 1979 to Slater et al. and 4,417,791 granted November 29, 1983 to Erland et al., such patents relating to traveling matte cinematography, i.e., motion pictures or video. It has also been proposed to produce still composite pictures using continuous lighting, illustrative of which is United States Patent 3,149,969 which was granted September 22, 1964 to Petro Vlahos. However, when practicing prior proposals, it has often been necessary for an operator to perform manual touch-ups of the composite so as to eliminate tell-tale indications that render the composite unrealistic. Moreover, while a minor mis-match can be tolerated in motion picture composites due in part to the rapidity with which individual frames are projected

and the inability of the human eye to discern minor anomalies in such rapidly changing projections, a higher degree of matching must be employed for still-type image capture to produce seamless integration that appears genuine.

As will be observed from reference to United States Patent 3,149,969, it has been customary to use continuous illumination for composite still photography. There have been a variety of reasons. These include the simplicity of continuous illumination, its spectral characteristics and its low cost. Moreover, when used with conventional photographic film and previewing equipment such as a video display, continuous illumination has been generally compatible with the color characteristics of the backdrops, the film and the video camera, thus contributing to facility of use.

Although photographic flash illumination such as strobe lighting has been used in studio portraiture and in specialized motion picture applications, it has presented certain problems and disadvantages in the production of still image composite photographs. Thus, for example, strobe illumination is more complex and costly than conventional continuous lighting. Moreover, when including image capture on two or more different photosensitive media, optimum levels of strobe light needed for exposing conventional color film typically have overpowered electronic imaging equipment such as video cameras or have tended to wash out the color characteristics of backdrops. Synchronizing problems have heretofore been encountered in coordinating the timing of differing image-capturing devices such as film cameras, video imaging devices and brief duration illumination sources. Accordingly, the practice of seamless composite still photography has heretofore been accomplished with continuous conventional lighting.

Although the use of continuous conventional lighting and the attendant equipment therefore have the advantages of simplicity, dependability and low cost, they also present some disadvantages. These include excessive heat and the inefficient use of electricity, both in providing the lighting, and also in operation of air conditioning or ventilating equipment required to maintain the ambient room temperature at a reasonable comfort level. Continuous lighting sources also lack the advantage of being able to freeze action for a live subject such as is necessary in many professional photography or studio portraiture situations. Accordingly, there has been a need for further improvements in seamless composite still photography.

Brief Summary of the Invention

To ameliorate the foregoing disadvantages of the prior art, provision is herein made to utilize characterizing backdrops, which in the preferred embodiment are process screens having characteristics that are computer distinguishable from foreground objects. These process screens are employed in combination with photographic flash illumination, such as provided by strobe lights, in such a way as to avoid process screen wash-out while being coordinated with any of a predetermined plurality of image capturing components such as still cameras with conventional film, charge-coupled devices, video capture and display. Thus advantage is taken of the full potential of strobe photography, thereby expanding the utility of composite photography to the professional photographer.

To facilitate compositing of the desired subject and background, data representing one or more selectable backgrounds are digitally encoded and stored in a memory associated with a conventional digital computer. Also stored are accompanying data severally representing important lighting characteristics that are employed automatically to position and condition system lighting to correspond to selected backgrounds; and also included may

be data relating to color characteristics. Collectively, these may be referred to as background templates.

When the image of the subject is captured, it is digitized and stored in addition to being used to condition a display so that an operator and the subject can view and approve the captured image before it is melded with the selected background.

The system also includes other features such as dual-mode system shutoff to provide an emergency or orderly shutdown, operator-actuated photo type touch up, automatic system calibration and color monitoring to provide automatic color compensation.

The methods and apparatus according to the invention are specially adaptable to employment of digital processing of both the background and foreground portions of the proposed composite utilizing a variety of integration techniques.

The foregoing is accomplished through the cooperative combination of characterizing backdrop (e.g., process screen) techniques with image capture modes coordinated with controlled flash illumination to produce still image representations that include a characterizing background together with a desired foreground, the latter typically being a person or object a photographer desires to incorporate into a selected image. The still image representations are particularly adaptable each to being scanned and digitized electronically for combination under the control of a computer with a selected background into a composite image that appears genuine and realistic.

By practicing the principles of the inventions hereof, problems of the prior art are substantially overcome, thereby economically rendering an attractive composite still image capture. This is accomplished by combinations employing the use of storbe lighting, process screens, still and video cameras, solid state imaging devices such as charge-coupled device imagers, digital image recording,

digitally stored background images specially adapted for seamless integration, computer control and digitally controlled automated lighting including improved lighting robotics and automated digital intensity control, imaging sensitivity control to make compatible differing characteristics of differing imagers, improved scanning and processing discrete regions adjacent important boundaries, i.e., feathering, improved synchronization circuits that are readily adaptable to a wide range of existing components, discretionary corded or cordless trip devices, and dual-mode supervisory circuits for emergency or orderly shut-down. By manipulation of an emergency shut-down element such as a designated key on the operator keyboard, system operation is immediately shut down; whereas if an orderly and non-emergency shut down is desired, provision is made for manipulation of a different shut-down element, whereupon the system proceeds to an orderly stopping with the point at which stoppage occurred being recorded so as to provide for an orderly resumption.

Objects and Features of the Invention

It is one general object of the invention to improve seamless photographic integration.

It is another object of the invention to enhance comfort of subjects whose visual image is being recorded.

It is another object of the invention to increase efficient use of lighting in producing still photographic images.

It is still another object of the invention to prevent wash-out of the characteristics of process screens when employing photographic flash illumination.

It is yet one other object of the invention to enhance image quality by preventing the blurring of the capture that otherwise might occur if the subject moves during exposure.

It is still another object of the invention to facilitate system operation by providing automatic calibration and

color compensation to compensate for a wide variety of pre-existing or changing ambient conditions.

It is yet another object of the invention to provide improved coordination of camera shutter, video electronics and flash illumination to provide dependable and relatively trouble-free operation.

Accordingly, in accordance with one feature of the invention, photographic flash or flash illumination such as strobe lighting is employed in combination with a characterizing background such as a process screen and an image-capturing medium, thereby improving efficiency and comfort.

In accordance with another feature of the invention, and in the preferred embodiment, conventional video capture is employed in combination with a process screen background, flash illumination and still photography imaging, thereby facilitating real-time monitoring, subject posing and frame capture.

In accordance with yet another feature of the invention, through the use of flash illumination, provision is made to over-power adverse lighting characteristics that may otherwise be introduced by ambient lighting conditions at the time of capture, thereby facilitating the photographer to consistently reproduce and control the intensity and characteristics of the image-capturing operative light.

In accordance with still another feature of the invention, automatic calibration circuits are provided to coordinate timing interrelationships between flash, camera shutter and video capture, thereby simplifying operator use.

In accordance with yet another feature of the invention, color monitoring and compensation are provided to monitor color response and to provide automatic color compensation and exposure, thereby aiding in faithful color renditions.

In accordance with still a further feature of the invention, provision is made for automatic digital compositing of captured images and backgrounds.

In accordance with yet another feature of the invention, provision is made for facilitating operator touch-up and control, thus simplifying such touch-up and reducing time required therefor.

These and other objects and features of the invention will be apparent from the following description, by way of a preferred embodiment, with reference to the drawings.

Brief Description of the Drawing

Figure 1 is a perspective view illustrating a studio having

Figures 2a and 2b are a simplified system diagram illustrating principal components of a basic system;

Figure 3 is a more extended system diagram;

Figure 4 is a diagram illustrating the sequence and interaction within the image capture phase according to Figure 3;

Figure 5 is a diagram illustrating the order fulfillment phase according to Figure 3;

Figures 6-11 are flow diagrams illustrating the sequence and interaction of system operations;

Figure 12 is a diagram illustrating operation of the flash camera coordination circuits;

Figure 13 is a coordination circuit timing diagram;

Figure 14 is a diagram illustrating operation of the auto calibration circuits; and

Figure 15 is a diagram illustrating opertion of the auto color monitoring and compensation circuits.

Description of a Preferred Embodiment

Before turning to the figures, reference is made to copending United States Patent Application Serial Number 29/009,510 filed on June 15, 1993, the description of which is hereby incorporated by reference. It also may be helpful

to define the following terms as employed both in this specification and the attendant claims:

Characterizing background means an intentional backdrop having predetermined characteristics that are identifiable by imaging devices and distinguishable by digital processing equipment from foreground objects. Included within such definition are projected monochromatic light and Process Screens.

Chroma Key means the process of selecting a color in video imaging (usually a cobalt blue or lime green color) and defining it to the system as the key color which represents nothingness image-wise such that it will not be exposed as an element of a picture. Thus, it is employed in a composite for getting an image only of the subject, with nothing exposed around the subject.

Garbage Matte means the process by which any captured secondary subject (such as that which is used in posing or a rig component) other than that intended for compositing into the background may be de-selected, i.e., "matted out" of the subject image before performance of the compositing step.

Process Screen or Process Screens means one or more physical backdrops having a uniform surface color of a relatively narrow spectral range, a predetermined pattern adapted for imate recognition, luminescence or a predetermined character, polarized transreflectance, or a combination of two or more of the attributes.

Photographic Flash or Flash Illumination means an intense light of brief duration that is intentionally activated in order to provide principal illumination for capturing an image by a photosensitive medium. Included within such definition are Strobe or Strobe Lighting, as defined below.

Strobe or Strobe Lighting means an intense light of extremely brief duration emanating from the gaseous discharge of electrical current through a gas discharge member.

Request for Flash Signal means a mechanical indicia or electrical signal intentionally designated to result in immediate or momentarily delayed activation of a Photographic Flash.

Now turning to the drawing, and more particularly Figure 1 thereof, it will be seen to portray a photographic studio generally shown at 10. Preferably included within this studio are conventional lights (not shown) positioned so as to provide an acceptable level of continuing ambient light for purposes of posing chroma key. Also included within this studio is Process Screen 11 having a surface 12 that is characterized as set forth in the foregoing definition.

Positioned in front of surface 12 and above surface 14 of a floor or other support 15 is foreground subject 13 whose image is to be captured by an image-capturing device such as camera 16. While not necessary to the practice of the inventions hereof, the camera 16 is preferably made movable in any of the three directions defined by arrows c-c (side-to-side direction), d-d (vertical direction) and e-e (forward and backward direction). Provision is also made for pan, tilt and zoom.

Also, while not necessary to the practice of the inventions, to support the strobe lighting assembly (which is hereed), there is provided a structural support h may take any of a number of known geometrical forms such as the convsupport shown which includes vertical and horizontal support members 17, 17a and 17b. Attached to support members 17 and 17a by any suitable means are optional guide rails 18 and 18a having tracks 19 and 19a in which the lower portions 20 and 20a of a hemispherically shaped support 21 may be moved forward or rearward as shown by arrows f-f. Also provided at points of movable attachment of hemispherical support 21 to guide rails 18 and 18a are pivots 22 and 22a which permit controlled pivoting of support 21 in the directions shown by arrows a-a.

Hemispherical support 21 preferably includes conventional tracks, grooves or the like with which mating conventional movable supports (not shown) for strobe light 23 engage. By virtue of such conventional mating movable supports, Strobe Light 23 can be moved along a hemispherical arc corresponding to the arc of hemispherical shaped support 21 as denoted by curved arc segment b-b.

While not necessary for the practice of the inventions hereof, provision is also preferably made for bi-axial movement of the position from which light emitted by strobe light 23 is directed. That, together with movement along the hemispherical path defined by hemispherically shaped support 21, provides improved adjustability for the strobe unit 23.

Further reference to Figure 1 reveals the presence of optional additional imaging device 25 which may be a video camera or charge-coupled device still camera. Also depicted are strobe synchronizing module 28, light intensity coordinating module 29, computer 30 and computer keyboard 31. As mentioned above, strobe synchronizing module 28 is provided to coordinate the timing of the strobe flash with the shutter of a conventional film camera, if used, or with the scanning sequence of charge-coupled devices if employed in practicing the principles hereof.

Also, as mentioned above, when the principles of the invention are employed with imaging devices having different levels of sensitivity, it is desirable to provide for coordination therebetween by adjusting the sensitivity of one or more of such devices so that they are compatible with each other and with the level of lighting provided by the strobe. Thus, since it is known that when a video camera such as camera 25 is utilized with an imaging device such as film camera 16, the level of light employed with conventional color film tends to overpower the video camera and result in a washed out image. The light

intensity coordinating module produces an electrical signal to wqhich the otherwise overpowered imaging device is responsive to lower the sensitivity of such imaging device for the duration of the strobe flash, thus coordinating such device and preventing undesired over exposure. Correespondingly, after the conclusion of the strobe flash, the imager is returned to its previous state which normally is adjusted for levels of ambient lighting that ordinarily are provided within the studio.

Circuits capable of providing the foregoing coordinating signal are known in the art and may take the form of any of a variety thereof.

Now turning to Figures 2a and 2b, there is shown a flow diagram depicting the sequence of actions performed by a simplified system illustrating selected components of a basic system. A necessary step in practicing the invention is to deploy a characterizing background such as a Process Screen in the desired location. This is represented by rectangle 40 "Positioning Process Screen." It is also necessary to deploy or position a still frame imaging device. This is represented by rectangle 41 "Positioning a Still Frame Imaging Device."

In the preferred embodiment, when the Process Screen and still frame imaging device are in the desired position, a selected subject is interposed between the imaging device and the Process Screen. This is represented by rectangle 42 "Interposing a Selected Subject Between the Imaging Device and the Process Screen." Next, and after any posing of the subject that may be necessary or desirable, and any desired repositioning of the light sources, the operator (not shown) initiates a Request for Flash. This is represented by rectangle 43 "Request for Flash." Such request may be initiated by any of a number of known devices. In response to the Request for Flash, an electrical Request for Flash Signal is generated as by

circuits well known in the art. This electrical signal is represented by rectangle 44 "Request for Flash Signal."

For embodiments that employ a still frame imaging device, the aforementioned Request for Flash Signal 44 is communicated directly to the input 50 of the activating circuits of the Strobe Light 23 (Figure 1) as represented by the "Strobe Fires" rectangle 51 of Figure 2b. However, in embodiments utilizing both a video and a still imaging device (either digital or film), the occurrence of the Request for Flash Signal at path 45 and a suitable video field coordination signal on path 52 results in an activating output being conducted over path 49 to the aofrementioned sensititivyt coordination circuits represented by rectangle 48 "Sensitivity Coordination", where they initiate an adjustment of the sensitivity of the video imaging device so as to cause it to be compatible with the level of light emitted when the Flash Illumination device, e.g., Strobe Light 23 (Figure 1) fires. When the sensitivity coordination circuits are activated, an electrical signal is conducated via path 50 to fire Strobe 23. The resulting Flash Illumination of the subject and Process Screen is represented by path 53 and rectangle 54 "Illuminates Foreground Object and Process Screen." While the subject and Process Screen are illuminated, one or more images are captured by the still frame imager and, if included, by any other imagers. This is represented by path 55 and rectangle 56 "Image Recorded by Imaging Device(s)."

In considering the foregoing, it will be evident to those skilled in the art that coordination of sensitivity adjustment can be accomplished in many ways including reducing the gain on the camera, attenuating the video signal, or introducing or controlling a neutral density filter. This can also be done manually as by adjusting a lens iris or automatically as, for example under control of a solenoid whose action is coordinated with the Request for Flash Signal.

The foregoing is an elementary description of a simplified form of the system hereof for which additional details are included in the following figures. Thus, Figure 3 illustrates in block form an actual operating system in which system components are grouped in eight modules numbered 1-8. These modules are identified respectively as Motion Control Sub-System 1, Strobe Sub-System 2, Coordination Unit 3, Camera Sub-System 4, Capture Workstation 5, Imaging Workstation 6, File Server 7 and Print Processor(s) 8.

Grouped with Motion Control Sub-System 1 are motion control computer software 1a, conventional computer system interface 1b, conventional steppint motor deiver circuitry 1c, camera and light positioning stepper motors 1d, and rig hardware 1e. Rig hardware 1e includes the aforementioned herispherically shaped support 21 and attendant conventional hardware equipment.

Grouped with Strobe Sub-System 2 are strobe control computer software 2a, conventional computer system interface 2b, strobe power packs 2c, and strobe heads 2d.

Grouped with Coordination Unit 3 are NTSC decoder 3a, trigger circuits 3b, video stage coordination circuits 3c, camera stage coordination circuits 3d, strobe stage firing circuits 3e and optional other device stage circuits 3f.

Grouped with Camera Sub-System 4 are camera sub-system computer software 4a, computer control interface circuits 4b, CCD digital camera (e.g., video) 4c, film camera 4d, computer controlled lens circuits 4e for providing sensitivity adjustment, and process screen 4f (corresponding to screen 12 in Figure 1).

Grouped with Capture Work Station 5 are background template database 5a, Capture Work Station computer software 5b, Capture Work Station computer interface 5c, template interface 5d, image data interface 5e, frame buffer 5f and viewing screens (monitors) 5g).

Grouped with Imaging Work Station 6 are Imaging Work Station(s) template database 6a, Imaging Work Station(s) computer software 6b, Imaging Work Station(s) computer system interface 6c, imaging data interface 6d, frame buffer 6e and viewing screen (monitor) 6f.

Grouped with File Server 7 are customer final image database 7a, customer image archival memory 7b and file server computer system interface 7c.

Grouped with Print Processor(s) 8 are print processor(s) template print database 8a, print processor computer software 8b, computer system interface 8c, and network/printer interface 8d. Also with group 8 are printer options 8e and 8f which are shown to illustrate the capability of the system to include simultaneous or sequential outputs to multiple photographic similar or different printers.

In addition to the foregoing eight groups, there are also shown intermediate data transmission and reception modules 60 and 61, photo trigger (request for flash) input 62 and labelled interconnecting paths. The operations and functions of these, together with the modules 1-8 will be more evident from the following description of the ensuing figures.

It will be obvserved that in Figure 3, modules 1-5 inclusive lie above dashed line 63 and are generally identified with a caption "Subject Image Capture Phase." Correspondingly, modules 6-8 lie below dashed line 63 and are generally identified with a caption "Order Fulfillment Phase." Figures 4 and 5 illustrate interaction within and between the Subect Image Capture and Order Fulfillment Phases.

Now turning to Figure 4 and the Image Capture Phase, it will be seen to portray an Order Entry station represented by computer symbol 65. There, orders are entered using a conventional computer keyboard (not shown). In response to manipulation of the keyboard keys,

information is entered to record items of information such as the identity of the customer, desired background scene, styles, sizes, and quantities of photographic prints desired, methods of payment, credit card numbers and any other items necessary or desirable to complete the customer's order. Thus, an entry is made in a customer tracking data base which may be located within computer 65 or preferably (as represented by path 66) in file server 67. In response thereto, order entry extends via file server 67 to send an unlocking signal via path 68 and 69 to unlock Imaging Workstation 70 (Figure 5). At the same time, a signal is conveyed as illustrated by path 71 to enable capture workstation 72 and permit it subsequently to capture an image of the subject. Also applied to capture workstation 72 is a signal represented by path 73 leading from order entry station 65 for communicating scene selection information needed for processing and setting the motion and lighting control system as hereinafter described.

Leading from capture workstation 72 to motion/lighting control system station 74 is path 75 which represents lighting criteria data transmitted to station 75. As previously mentioned, such lighting data is used to condition the lighting system to provide characteristics such that the subject whose image is to be captured will appear to have been lighted by the same or similar light as that which lighted the background image. In response to receipt of this information, system 74 extends conditioning signals via paths to correspondingly condition the characteristics (such as direction, intensity, hue, shadow conditioning and density) of strobe light(s) 78 and to drive rig motor(s) 79 to correspondingly set the physical position(s) of lights to the desired locations.

Certain cameras may permit compensation for color and gain correction to compensate for abnormal camera or ambient lighting conditions. Where such cameras are used,

provision is made for compensation as represented by path 80 over which template color correction and gain data are transmitted to the camera from workstation 72. Path 81 conducts a camera iris controlling signal from station 72 to iris 82 of computer controlled lens assembly 83. This signal is effective to set iris 82 to a relatively open state to permit passage of sufficient ambient light therethrough to properly register a subject on the digital camera 84. This includes not only an image of the subject that is employed for posing but also information on the spectral characteristic of the background against which the subject is being posed, such spectral characteristic being generally referred to by those skilled in the art as "Chroma Key" information. Transmission of a posing image and associated Chroma Key information is communicated from camera 84 via path 85 to capture workstation 72 where it is displayed on monitor 72a. It may optionally also be displayed on one or more other monitors, preferably including one that is readily viewable by the subject so that the subject may audibly communicate his/her assent to the pose. After posing, the system operator initiates selected image capture by activating a "shoot trigger." As the name implies, it is the device that produces a signal to initiate operation of the glash coordination circuits and the capture of the image which is to be melded together with a selected background to form the selected composite image.

As previously mentioned, the "shoot trigger" may take any of a number of conventional forms. It may be a push button operated single pole, single throw electrical switch with cable connection or radio frequency transmission communication, a keyboard key, or any of a number of other conventional devices. In any event, when the shoot trigger 86 is actuated, an asynchronous signal is communicated to coordination un it 87 where (as is described in detail below) it is effective to produce signals that are conducted via paths 88-91 as follows. Over path

88, a signal is communicated to computer controlled lens assembly 83 where it is effective to cause iris 82 to close down to a level commensurate wevel of light to be emitted by strobe light(s) 78 when they fire. Coordination unit 87 also responds to a benchmark signal that is continuously emitted from digital camera 84 and communicated to coordination unit 87 via path 92. This benchmark signal corresponds to the scanning read-out of the digital array and identified the then-current position of the read-out in the read-out cycle, thus permitting the coordination unit 87 to continuously monitor the digital read out sequence. When a predetermined read-out sequence condition occurs (as is described in detail below), the coordination unit 87 initiates timing sequences that coordinate operation of the shutter mechanism of film camera 93 via path 89, switching of capture workstation from Chroma Key mode to still image capture mode via path 90, and firing of the strobe light(s) 78 via path 91. Thus, firing of the strobe light9s) 78 occur at a time when the camera sensitivity has been reduced through reduction of iris 82, when pixels (or other light responsive elements) are in condition to be evenly flash illuminated, when the shutter of camera 93 is momentarily open, and when the mode at capture workstation 72 has been switched from Chroma Key to still image capture mode.

The captured image is digitally stored at a conventional intermediate storage memory in capture workstation 72, after which a corresponding representation is sent as represented by path 71 to file server 67. Transfer of the image may be by direct electrical connection, by modem, direct disk transfer, network, or other known means as needed.

Now turning to the Order Fulfillment Phase as represented by Figure 5, it will there be seen to include file server 67 which, as previously described, is connected to imaging workstation 70 via path 69. Operator manipulation

of a conventional keyboard (not shown) associated with workstation 70 is effective to transfer the digitally recorded image into Imaging Workstation memory for further processing including identification of the characterizing background so as to effectively eliminate it from the succdeeding composite. It is also effective to transfer a digitally stored representation of the desired background (selected by the customer) into workstation memory where it subsequently will effectively replace the characterizing background and some portions of the customer images as well. The workstation also performs other desired functions including detection of subject image outline and feathering of the outline edges to facilitate a realistic blend of image and background, supression of reflection of process screen onto the subject, and color adjustment to closely match color characteristics of the subject and background. Since location and condition of each tiny portion of the composite image is digitally represented, and since a visual representation of the composite image is displayed on imaging workstation display 70a, manual operator keyboard manipulation can effect cosmetic changes as necessary or desirable. Thus, the Imaging Workstation operator can concurrently view the modified composite image on monitor 70a while making desired cosmetic or other visual changes.

It should be noted that due to the digital format and recording in active memory of both the background and foreground (subject) images, changes in image composite may readily be made before image printing or other further processing occurs. This provides beneficial flexibility not only for correcting such matters as blemishes but also for changing other characteristics such as the default color hues and intensities, shadows and other composite characteristics. It also provides the important advantage of positioning flexibility, for the subject image may be moved to any desired point in the selected

background and may be made to appear to be in front of all or a portion of the background object(s), or be wholly or partially behind such background object(s).

In addition to the foregoing, Imaging Workstation 70 provides a wide range of features and operator options. Thus, for example, it includes optional automatic color correction for correcting subject image color to coordinate with colors of the selected background, optional automatic flash coordination timing calibration, correction for light reflection from the characterizing background, and on-going dynamic color correction to compensate for changes in characteristics of light produced by the source of flash illumination, an example of which is the change in characteristics due to flash tube aging.

After the system operator has completed the above-described changes to the composite scene, and upon manual manipulation of the imaging workstation keyboard, a digital representation of the corrected composite image is transferred to print processor 100 as by path 101. There, any additional information (such as logos and copyright notices) are received as by path 102, after which a digital representation of the completed composite is transferred as by paths 103/103a to one or more printer output devices 104/105. Such printer output devices may include a photographic printer, a film recorder, a plotter or the like. After the desired records (e.g., prints, films, plots or the like) have been made, the system proceeds to produce a customer invoice and stores desired records in memory, for example in high capacity memory within file server 67. Alternatively, such customer records may be stored in separate conventional disk or tape form. Thus, ready provision is made for responding to future customer requests/orders as, for example, for additional copies, copies of different sizes and the like.

Now returning to the sub-systems portrayed in Figure 3, it will be observed that in order to position and condition

system components to provide images that are coordinated with selected backgrounds (as mentioned above), there are provided motor-operated positioning devices including rig elements that are continuously adjustable. These include the hemispherical hoop and attached adjustment devices mentioned above to provide adjustment of lighting color, lighting diffusion, lighting angle with respect to the subject, camera angle with respect to the subject, camera distance to the subject and depth of field found in the selected background image. To accomplish this, as will be evident to one skilled in the art, there preferably are provided control of dolly, lift, roll pan, tilt, hoop, trolley, color wheels, diffusion wheels, zoom, and focus. Individual control for each of these is provided by conventional motors that are responsive to control data transmitted thereto as described above. Thus, digital data relating to optimum conditioning of the foregoing conditions is stored in memory for each available background; and when a background is selected, the relevant data is transmitted to the related stepping motors and other controls to condition them accordingly.

Reference again to Figure 3 shows analogous controls for the strobe power packs and flash heads. Again, as with the motion control sub-system, relevant data corresponding to the selected background is transmitted to the strobe power packs and strobe head positioning motor(s) to set them to the selected conditions.

Proceeding now to other interrelationships between parts of the overall system of Figure 3, reference is made to Figures 6-11 which portray a sequential flow diagram for the system. To begin operation (after the various equipments are turned energized), a start sequence is initiated by depressing a start key 110. The system operator then enters a customer order 111 as discussed above. Each order preferably is assigned an incremental order number as represented by rectangle 112. Order information is then recorded in tracking database as

represented by trapezoid 113, and a signal is transmitted to activate (open) the capture station as represented by trapezoid 114. The capture station is thus initialized and made ready for use as represented by rectangle 115. Next, the operator identifies the background selected by the customer as shown in trapezoid 116. The capture station then loads chroma key background information into memory as represented by rectange 117 after which it transmits the above-described conditioning information to the motion control system (trapezoid 118), resulting in operation of the motion control system to move the rig into the desired position (rectange 119). Lighting data is also transmitted to the lighting control system (trapezoid 120) to correctly condition intensities and other characteristics for the flash strobes (rectangle 121). A frame buffer (temporary image storage prepares for chroma key input (rectange 122), after which color data is transmitted to the digital camera (trapezoid 123) and the digital camera applies color correction (rectangle 124). The capture workstation then begins chroma key operations (rectangle 125) and a image of the subject with chroma key is outputted to the workstation visual monitor (trapezoid 126). Next, turning to the top of Figure 7, the operator poses the subject before the characterizing screen (rectangle 127) and, when the customer and operator are satisfied with the pose, the operator presses or otherwise activates the shoot trigger (rectangle 128) thereby to pulse the coordination circuitry (trapezoid 129). The aforementioned signal is transmitted to the camera lens (trapezoid 130) to reduce the lens iris so as to reduce the effective sensitivity to a level commensurate with the selected level of flash.

As mentioned above, the system monitors the digital scan readout (trapezoid 132), analyzes it and aligns timing of system components as described in detail below (rectangle 133). At a coordinated time, the film camera is

triggered (trapezoid 134) and the film camera shutter is actuated (rectangle 135). Correspondingly, at a coordinated time, the capture station is activated (trapezoid 136) to initialize its frame buffer for image capture (rectangle 137). Again, at a coordinated time, the strobe system is triggered (trapezoid 138), thus firing the strobe rectangle 139) and resulting in the capture of a properly exposed digital and film image (rectangle 140).

Now continuing with Figure 8, the digitally captured image is transmitted to intermediate storage (trapezoid 141 and rectangle 142 where it is held until called up during the above-identified fulfillment phase (trapezoid 143).

It will be recalled that the lower part of Figure 3 was designated as the order fulfillment phase, and included group 6, imaging workstation(s), group 7, the file server and group 8, the print processors. Thus, trapezoid 144 in Figure 8 represents receipt at the imaging workstation of the subject and background images where they are temporarily stored in intermediate storage as represented by rectangle 145. Accordingly, they are available for modification (such as touch up) and further processing under control of the imaging workstation operator.

As mentioned above, provision is made for comprehensive photographic modification by the workstation operator. Initiation of such is represented by trapezoid 146 (Figure 9) which includes loading of image elements into workstation random access memory (RAM) (rectangle 147 and the automatic recognition and processing of the characterizing screen matte (i.e., that part of the subject image capture that consists of the characterizing color) as represented by rectangle 148. The outline of the subject image is then automatically detected and feathered (rectangle 149) so as to blend it to the background image and thus provide a natural and genuine appearance. Operation then proceeds to a modification default mode 150 in which if manual modification is

needed, the system pauses to provide therefor (trapezoid 151), after which it proceeds to the performance of automatic garbage matte (rectangle 152). However, if at node 150 it is determined that manual modification and feathering is not required, the system proceeds directly to the step of performing the automatic garbage matte 152. Thereafter, operation of the system proceeds to node 153 in which if manual modification of the garbage matte is needed, provision is made therefor (trapezoid 154) after which the sequence proceeds to an automatic positioning of the subject (rectangle 155).

Figure 10 begins with modification default node 156. There, if manual modification of subject positioning is not required, the system proceeds directly to blue suppression and reflection removal (rectangle 157). However, if manual modification is desired, system operation proceeds as by trapezoid 158 and thence via blue suppression and reflection removal rectangle 157 to automatic color correction (rectangle 158). Thereafter, it proceeds to modification default mode where, if no manual modification is desired, the system proceeds directly to the step of compositing the mattes (rectangle 160); or, if manual modification is desired, via trapezoid 161 which represents the manual performance of color correction.

The composite is now ready for operator preview of the final image (trapezoid 162), after which the operator selects formats for the desired prints (trapezoid 163). After making an entry identifying the desired prints, system operation proceeds to Figure 11 where transmission of the final image to the print processor is symbolized by trapezoid 164. Concurrently, there is transmitted information identifying the selected format for the completed print (trapezoid 165), and thereafter the print processor performs its layout and paste-up (rectangle 166). Logos, captions and bitmaps are added as denoted by rectangle 167, and the completed data are then transmitted

to the printer (trapezoid 168). The printer then processes the data (rectangle 169) and produces prints as selected (treapezoid 170). Thereafter, when the printer has completed its work, the sequence concludes as denoted by "Stop" label 171.

Retuning now to the coordination unit (Group 3 in Figure 3), it will be recalled that (as described above) it monitors the signal emanating from the video camera so as to identify regularly recurring benchmark points in its syclical read-out. At this point, it should be noted that benchmarks may differ, depending on the type of video device in use. In accordance with the embodiment hereof, a conventional NTSC video imaging sequence is emplolyed and accordingly, a particular series of benchmark points are hereinafter described. In the NTSC system, each full image (i.e., frame) is scanned in two increments that are identified as odd and even fields; and in order to obtain optimum image capture, it is desirable to illuminate imaging pixels evenly so that both odd and efven fields are optimally utilized. Although in the embodiment hereof, NBTSC imaging is employed, it will be evident to those skilled in the art that other solid state imaging may be employed; and that where different imaging is utilized, benchmark points will change. In any event, after a request for flash is made as represented by the shoot trigger 175 (Figure 12) and after conventional anti-bounce circuit 176 has prevented sup[urious response, the cooredination circuits continue to monitor the cyclical read-out. When a predetermined point is reached (e.g., the beginning of the next paired field read-out in present NTSC systems or corresponding beginning of frame read-out in other systems as represented by rectangle 177), conventional logic "and" circuits 178 answer "yes" to the question "Are both shoot and readout in a start condition. When this occurs, a corresponding signal is transmitted to activate both timer 1 (item 178) and timer 3 (item 179). When timer 1 times out, it sends an open

camera shutter signal 180 to camera 181 where it causes the shutter to begin opening. At the same time, it starts timer 2 (item 182) running so that after it (timer 2) times out, a flash fire signal 183 is transmitted to fire the flash (rectangle 184). While the timing sequences of timers 1 and 2 are in operation, timer 3 (179) is in operation, and after timer 3 times out, it sends a signal to enable the frame buffer capture card (not shown) so that it is prepared to capture a full frame image (rectangle 185).

The interrelationships between the timers and sequences of Figure 12 can better be understood from reference to Figure 13. There, it will be observed, is a timing sequence illustrating the timing interrelationships of shoot switch 175, timers 1-3 and the CCD image readouts. The objective, of course, is to have the flash occur at the beginning of a video image frame readout so that each pixel will have been properly illuminated. At the same time, the shutter of the camera should have just reached its open position, thereby creating the circumstance of frame exposure, and the CCD image capture card should be been switched from Chroma Key to image capture mode so that it will process/store the flash-exposed CCD image of the subject. These objectives are achieved through the advantageous recognition and utilization of the regularly recurring cyclical read-out of the successive frames and the recognition that the time between successive readouts is known and uniform; or, if not known, can be ascertained. In Figure 13, the time is shown as being uniform and is represented by T4 (items 190). To assist in the following discussion, four sequential read-out sequences (scans 1-4) are portrayed and the times for these are identified respectively 190a, 190b, 190c and 190d. These timings are adjustable in anticipation of other video scan types as well as to compensate for a variety of timing variances based upon available off-the-shelf equipment.

As mentioned above, it is desired that a flash occur at the first suitable point in the scan sequences following activation of the shoot trigger. In order to determine this, the circuitry monitoring sequential read-out maintains cognizance of the moment during a scan cycle when the shoot trigger (191 in Figure 13) is activated. If it occurs during the interval represented by Trigger interval 2, when flash will occur at the beginning of Scan 4 at the end of T2. If, however, it occurs during the next interval corresponding to Trigger Interval 2, flash will occur at the beginning of Scan 5. The minute interval of time by which trigger intervals (e.g., interval 2) are advanced from the corresponding scan intervals is for the purpose of compensating for the circuits to respond to electrical signals.

Now considering the timing interrelationships in greater detail, it will be observed that T1 + T2 = T4. T2 represents the time required for the camera shutter to open after it has been awctivated and is made adjustable so that it can be set to correspond to the shutter characteristics of the particular camera that is used. Since T4 and T2 are known for any given video system, it follows then that T1 is readily determined, and the corresponding timer may be correspondingly set. It will, of course, be recognized by those skilled in the art that if the shutter opening time for the camera in use is known, timers T1 and T2 may be set initially to the corresponding times. However, if now known, then the times may be established experimentally or by way of automatic system calibration circuits to which reference is made below. In any event, if T2 is increased, T1 should be correspondingly decreased, and T2 if is decreased, T1 should be correspondingly increased so as to maintain their correlation to the equation T1 + T2 = T4.

As mentioned above, the image capture board is to be switched from its Chroma Key condition to its image

capture condition at a point in time that is coordinated with the strobe flash. Accordingly, and since minute though finite amounts of time are required to accomplish such switching, adjustable timer T3 is provided to produce a switching signal at a time T5 in advance of the flash so as to provide for such minute finite switching time as required by the Capture Work Station hardware operating system and application software. Thus, the image capture board is in a flash image capture mode at the instant of flash (beginning of Scan 4). In order to provide for different electrical, circuit characteristics and switching response times of the image capture board, operating system and software, timer T3 is made adjustable.

As mentioned above, the system includes an optional automatic calibration feature that simplifies initial installations or changes that may occur during system use. Most conventional still cameras include internal contacts that close when the shutter is fully open, electrical connections to such contacts being communicated exteriorly through what is known to those skilled in the art as an "X-Connector". When a strobe is used with a conventional still camera, and when the shutter opens fully, (the X-Connector contacts close), an electrical signal is communicated to immediately fire the strobe. This simple process is adequate for traditional portraiture due to the relatively low levels of ambient light typically employed, the relatively long period that the shutter is open (usually in the range of 1/60th to 1/1000th of a second) and the relatively short latency between strobe trigger signal and actual strobe fire (for all relevent intents and purposes, immediate). Such is adequate when utilizing a single traditional camera and a single strobe firing mechanism.

The system hereof according to the invention, however, requires more due to a higher level of ambient light generated by the illumination of the characterizing screen; the need to utilize more than a single film camera

and/or digital camera system (or other electronic image recording devices); and timing differences between the various devices which must be compensated for in order to simultaneously produce the same properly exposed image on each recording device. The desired condition that will bring about this result is shen each image recording device is in its recording state at exactly the same instant when the strobe tube(s) fire. This means that as regards each film camera, the shutter must be in its completely open position when the strobe pulse occurs and the shutter speed must be fast enough to render any ambient light insignificant. Each video-based recording device must be at the beginning of its frame scan cycle when the strobe pulse occurs. This is difficult when camera coordination is based on a video signal such as NTSC where the scan rate, the time it takes to record an entire image, is 1/30th of a second and the duration of the strobe pulse necessary to illuminate that image is on the order of 1/1000th of a second.

Most professional grade video cameras contain a "frame mode" of operation for recording images whereby an image is recorded in a single instant and subsequently read out to a destination device in the manner prescribed by the video signal that it utilizes. In NTSC, for instance, because each full image (i.e., full frame) is transmitted in two fields, a field would occur 60 times per second to maintain the illusion of a continuous video signal. Finally, each digital camera must receive its trigger just before the precise instant when the strobe pulse occurs and the computer must be signalled to "grab" and hold the image using its frame buffer rather than continuing to read the scanning signal continuously.

Considerations of concern for each relevant device include the duration of time between the input trigger signal and the physical device actuation. In a traditional film camera, this translates to the amount of time required

for the shutter to move from the fully closed condition to the fully open condition. This period time differs greatly based upon different off-the-shelf camera products utilized and the amount of usage (i.e., wear) logged by that equipment. On some cameras, as the unit is used, the shutter solenoid weakens and the amount of time that it takes to move the shutter from closed to open therefore changes. For strobe systems and digital cameras, the duration between device trigger and actuation (i./e., strobe fore and image capture, respectively) is relatively insignificant and can, for this application, be considered immediate. On video cameras, however, the duration between the trigger input and the capture occurrence is not known in advance. Because the video process is by nature cyclical, one first pre-determines the points along the video signal at which a single frame capture is possible when utilizing a "frame mode" of operation. Once these points are known, provision is made for detecting the occurrence of one of those points along the signal and then predicting the time of the next recurrence, such being facilitated by the regularly recurring cyclical nature of the video signals. If multiple video cameras are utilized, and if they all employ NTSC systems, they must be synchronized such that the possible points of capture occur simultaneously. Multiple video cameras based on different typoes of signal with different corresponding scan rates can not be synchronized unless the points of possible capture can be made to converge. A remaining consideration is the determination of the duration between generation of an input trigger to a recording device which will actually capture the video image (e.g., a frame grabber) and the time when the device actually performs that capture.

Once the shutter open duration is known for each film camera that will be used in the system and the capture trigger latency is ascertained for each frame buffer device, the effective trigger input of each device is delayed in

order to match the longer latency time. This makes the instance of triggering of each device purposefully dis-synchronous in order that the desired operation at the devices is appropriately coordinated.

In accordance with the system hereof, the required delay for each aindependent device is entered as a preset in its own electronic timer (as is hereinafter described). A next task is then to match the longest device latency time (now the total device time to image capture) to a future possible instance of video capture by triggering the sequence in the proper relation to the video signal. At this point, each of the device timers begins counting. As each timer times out, it triggers its respective device which then begins actuation. When all the delays are set appropriately, each device will arrive at its recording state and the strobe(s) will fire at a single exact and correct point in time.

As will be evident from the foregoing, a task is to determine the latency that exists for each device so as to ascertain the appropriate delay. This is accomplished according to the physical characteristics of each device and with timing tests, the latter being a part of calibration. In order to automatically determine the latency compensation for each device, there must be a way of determining when the device is in its recording state. By generating a trigger for a device at a known point in time, and by identifying the precise instant when the device has completed actuation, the latency time can be determined. For film cameras, the aforementioned X connector is a way to ascertain when the shutter is open completely. For digital cameras and strobes, the response can be assumed to be immediate. For video cameras, the instant of video capture is known. Thus, the remaining unknown is the capture latency for the aforementioned frame buffer; and as long as the capture board is triggered well enough in advance so that it has enough time to prepare, that can be determined to be the "next video frame" (i.e., the beginning of the next

scan cycle) for which a value also is known. When these values are known, the aforementioned electronic timers are set or updated to such values so as coordinate their times of operation.

From the description of automatic calibration herein, it wil;l be evident that the foregoing is made to occur by continuously monitoring the actual device latencytimes, comparing those times to the present timer values, and making compensation adjustments on the fly. Each of the foregoing devices is triggered with respect to the video signal, and the trigger time is therefore known. For mechanical devices such as conventional still film cameras (those with an X-connector or the equivalent), the actual device trigger time is also reported back to the system through the X-connector cable. For video devices, the actual device trigger time is the start of the next video frame, and that point in time is known. Once the trigger latency time for each physical device is known, the trigger timer values are set (either manually or automatically) correspondingly so as to cause each device to be in its capture state smultaneously. When this is completed, the system coordination devices are calibrated and the unit may be utilized for production operation. The unit will continually calibrate itself as shutter open speeds increase or decrease.

The auto-calibration feature is illustrated in Figure 14 in which there are portrayed the steps followed in practicing it. In the embodiment hereof, the cameras and lights are set to predetermined conditions which provide essentially for even illumination of the characterizing screen (rectangle 200). Subjects, if any, are removed to that only an evenly illuminated screen will appear to the cameras (rectangle 201). The above-described timers are then set to approximate settings as may be obtained from camera and video board specifications (rectangle 202), and auto-calibration is initiated by pressing of a suitable switch

or keyboard key (rectangle 203). After delays interposed by the above-described timers, the flash strobe fires (rectangle 204), thus illuminating the characterizing background.

Some still cameras include conventional beam splitters and two image capture modes: (1) conventional film and (2) a CCD imager. If the still camera employed in practicing the invention hereof normally provides only for film capture, than in achieving automatic calibration, a CCD imaging back may be temporarily substituted for the conventional film back. If on the other hand, the camera provides for the foregoing dual image capture modes, then the existing CCD imager is utilized. In either event, the still camera CCD imager is scanned (rectangle 205) and the scanned image is sampled. The samples are then compared to detect evenly/unevenly lighted areas (rectangle 207). If there are none, then it is apparent that the camera shutter was completely open at the time of the flash illumination. On the other hand, if pixels in one section are more or less illuminated than those in another section, it is apparent that the shutter was not completely open. Whether the shutter has not opened all the way or whether it has been open and begun to close can readily be determined from an identification of that part of the CCD array which includes the lesser illuminated pixels. If the lesser illuminated pixels are contained in that part of the array that is later exposed as the shutter is opening, then it will be evident that the shutter has not yet completely opened. On the other hand, if they are contained in that part of the array that is first exposed as the shutter is opening and is first obscured as the shutter closes, then it will be evident that the shutter has passed its fully open condition and is in the process of closing. Thus, timers T1/T2 are incrementally adjusted (according to a predetermined degree of adjustment) either forward or backward as at rectangle 208 to move toward

compensation. If, when the strobe next fires and the foregoing process is repeated, the areas are evenly lit, then further adjustment in succeeding calibration cycles is not undertaken. However, if further adjustment is required, it is undertaken until the pixels are evenly lit, at which time further adjustment is terminated.

As mentioned above, not only the still camera but also the normal CCD viewing camera (e.g., the video camera) and the corresponding CCD (video) capture board also require flash coordination. Therefore, the auto-calibration hereof provides for scan sampling and comparison of the CCD (video) components and the CCD (video) capture board as is shown in the right hand side of Figure 14. The CCD (video) camera is scanned (209) and that scan is sampled as at rectangle 210 and communicated to video capture board 211. After sampling (210), the samples are compared by sample comparator 212 to determine which parts of the video scan are unevenly lit and adjustment of the flash trigger time is made accordingly, that it, either to advance or retard it depending upon which parts of the video scan are unevenly lit (rectangle 213). While this is occurring, the video capture board 211 is sampled and that sample is compared (214) with the output of scan sampling 210 so as to determine whether and to what extent video capture board 211 enabling times need advancing or retarding in time (rectangle 215).

As mentioned above, the system also includes features of continuous or periodic color monitoring to ensure continuity of faithful color rendition irrespective of changes that may occur due to aging or other changes in system components. Reference to Figure 15 reveals such color monitoring and compensation diagram. Provision is made for system operator optional activation of the auto color correction/compensation. This is represented by rectangle 220. An additional option includes selection of CCD camera imaging correction-compensation as

represented by switch 221 and/or remaining circuitry correction-compensation as represented by switch 222. For purposes of this description, it is assumed that both switch 221 and 222 are closed. However, it will be evident that the following description will be correpondingly applicable to the respective parts of the diagram when only one or the other of such switches is closed.

Assuming, for the moment, that switch 221 is closed, operation proceeds as follows. A standard color chart is disposed before the above-described characterizing screen and a request for flash is initiated as described above. When the flash occurs, it results in an image of the standard color chart 223 being recorded in the CCD imager 224. This recorded color chart is then read out (rectangle 225) by conventional circuits (as described above) and a digital representation thereof is communicated to comparison circuits 226. At the same time, there is communicated to comparison circuits 226 standardized digital data 227 which represents the standard or correct digital data corresponding to the standard color chart 223. Such data 227 may be permanently stored in system memory or temporarily introduced thereto as, for example, by use of floppy disks, tape, compact disks and the like. The read-out 226 and corresponding standard data are then compared by comparison circuits to detect any differences that are indicative of a lack in faithfulness of the CCD camera, and conventional color adjustment circuits are correspondingly actuated to effect CCD camera compensation as noted by rectangle 228. The CCD camera read-out is, of course, available for visual monitoring by the system operator, and manual overrise (not shown) is provided so as to permit visual adjustment if desired.

When switch 222 is closed and auto color correction 220 is on, color compensation is automatically provided for the remainder of the system. There, in the right hand portion of Figure 15 is represented a source 230 which is

communicated directly to comparison circuits 231 and to the image captureboard 232 to which reference is earlier made herein. Since it will be recalled form the earlier description that various intervening circuits are included between the image capture board and the viewer (operator) display board, such intervening circuits are represented by rectangle 233. The standard color digital diata thus passes through intervening circuits until it is received by viewer display board 234 whence it is displayed on system operator monitor 235 and introduced into comparison circuits 231. As with comparison circuits 226, comparison circuits 231 compare corresponding color-representing bits of digital data to identify any differences that may be indicative of lack of faithful data processing in the system. Such differences, if any, are applied to adjustment circuits 236 and color-correcting data is fed back via path 237 to capture board 232 in order to effect compensation. Of course, as with CCD camera color compensation, manual override (not shown) is provided to permit operator intervention and manual adjustment.

It will now be evident that there has been described herein, an improved seamless composite photography system and method that exhibit attractive features as mentioned above. It should aos be evident that the described System provides enhanced effectiveness while exhibiting improved operating characteristics; and that it is relatively simple in design and easy and cost-effective to produce and use, thus contributing to attractivensss and desirability.

Although the inventions hereof have been described by way of examples of a preferred present embodiment, it will be evident that other adaptations and modifications may be employed without departing from the spirit and scope thereof. For example, certain other types of cameras could be employed.

The terms and expressions employed herein have been used as terms of description and not of limitation; and thus, there is no intent of excluding equivalents, but on the contrary it is intended to cover any and all equivalents that maybe employed without departing from the spirit and scope of the invention.

CLAIMS

1. A system for forming composite images comprising: a characterizing background, a still camera for capturing an image of a subject against said characterizing background, a source of flash illumination, a flash coordinator responsive to a request for flash signal for coordinating said source of flash illumination with said still camera thereby to produce a still image of said subject and said characterizing background, digital means for producing a digital representation of said still image, one or more recorded selectable background images, selecting means for selecting one or more of said recorded selectable background images, and integrating means inter connected with said still camera and said selected one or more of said background images for realistically integrating said digital representation of said still image into said one or more of said background images.

2. A system according to Claim 1 in which said plurality of recorded selectable background images are recorded in digital form.

3. A system according to Claim 1 in which said integrating means comprises a digital computer.

4. A system according to Claim 1 in which said still camera includes photographic film for capturing said image.

5. A system according to Claim 1 in which said still camera includes a charge-coupled device imaging detector.

6. A system according to Claim 1 in which said still camera includes both a charge-coupled device imaging detector for capturing said image of said subject and photographic film for capturing said image of said subject.

7. A system according to Claim 1 further including a video camera for recording a video image of said subject.

8. A system according to Claim 1 in which said still camera includes a first charge-coupled device imaging detector of first predetermined size for producing a preview image and a second charge-coupled device imaging detector of a second size larger than said first predetermined size for producing said digital representation of said still image for integration into said one or more of said background images.

9. A system according to Claim 7 further including sensitivity adjustment means interconnected with said video camera for changing the sensitivity of said video camera to a level compatible with the level of light emitted by said flash illumination.

10. A system according to Claim 1 further including storage means for storing said digital representation of said still image.

11. A system according to Claim 1 wherein said characterizing background is a process screen.

12. A system according to Claim 1 wherein said characterizing background comprises a predetermined pattern.

13. A system according to Claim 1 wherein said characterizing background comprises a section of uniform color.

14. A system according to Claim 1 wherein said characterizing background comprises a predetermined pattern and a section of uniform color.

15. A system according to Claim 1 wherein said source of flash illumination is a strobe light.

16. A system according to Claim 1 wherein said flash coordinator is an analog electronic synchronizer.

17. A system according to Claim 1 wherein said flash coordinator is a digital electronic synchronizer.

18. A system according to Claim 1 further including still image recording means for recording said still image.

19. A system according to Claim 18 in which said still image recording means is electronic.

20. A system according to Claim 18 in which said still image recording is in film and electronic.

21. A system according to Claim 1 in which said selecting means includes a digital computer.

22. A system according to Claim 1 further including a source of lighting parameters for identifying optimum lighting conditions for said source of flash illumination.

23. A system according to Claim 21 further including a source of lighting parameters for identifying optimum lighting conditions for said source of flash illumination.

24. A system according to Claim 23 further including means for positioning said source of flash illumination.

25. A system according to Claim 24 further including data severally representing optimum lighting conditions for each of said recorded background images.

26. A system according to Claim 25 further including conditioning means responsive to selection of one of said recorded background images for correspondingly conditioning said source of flash illumination and for setting lighting to said optimum lighting condition.

27. A system according to Claim 26 wherein said conditioning means includes said digital computer.

28. A system according to Claim 26 further including a hemispherically shaped lighting support track and means for variably positioning said source of flash illumination on said support track.

29. A system according to Claim 26 in which said optimum lighting condition includes orientation, positioning and lighting intensity.

30. A system according to Claim 28 in which said optimum lighting condition includes orientation, positioning and lighting intensity.

31. A system according to Claim 26 in which said optimum lighting condition includes hue, shadow conditioning and density.

32. A system according to Claim 29 in which said optimum lighting condition includes hue, shadow conditioning and density.

33. A system according to Claim 30 in which said optimum lighting condition includes hue, shadow conditioning and density.

34. A system according to Claim 1 further including a hemispheric track for adjustably positioning said source of flash illumination.

35. A system according to Claim 1 further including means for detecting an emergency condition in said system and for automatically shutting down said system in response thereto.

36. A system according to Claim 1 further including means responsive to operator control for sequentially shutting down said system according to a predetermined pre-planned sequence.

37. A system according to Claim 1 further including hand-held means for activating said source of flash illumination.

38. A system according to Claim 37 in which said hand-held means is wireless.

39. A system according to Claim 10 further including recalling means for recalling from said storage means said electronic digital representation of said image.

40. A system according to Claim 11 further including a video camera for recording a video image of said subject.

41. A system according to Claim 18 further including a video camera for recording a video image of said subject.

42. A system according to Claim 22 further including a video camera for recording a video image of said subject.

43. A system according to Claim 2 wherein said characterizing background is a process screen.

44. A system according to Claim 3 wherein said characterizing background is a process screen.

45. A system according to Claim 4 wherein said characterizing background is a process screen.

46. A system according to Claim 5 wherein said characterizing background is a process screen.

47. A system according to Claim 6 wherein said characterizing background is a process screen.

48. A system according to Claim 1 further including automatic calibration means effective, when activated, for establishing optimum timing relationships between said source of flash illumination and said still camera.

49. A system according to Claim 7 further including automatic calibration means effective, when activated, for

establishing optimum timing relationships between said source of flash illumination, said still camera and said video camera.

50. A system according to Claim 9 further including automatic calibration means effective, when activated, for establishing optimum timing relationships between said source of flash illumination, said still camera, said video camera and said sensitivity adjustment means.

51. A system according to Claim 1 wherein said digital representation of said still image includes color data representing colors of said still image and wherein said system further includes color compensating means for sampling said color data and for automatically compensating said color data for maintaining faithful representation of said still image.

52. A system according to Claim 9 wherein said selecting means includes a digital computer and automatic calibration means effective, when activated, for establishing optimum timing relationships between said source of flash illumination, said still camera, said video camera, said sensitivity adjustment means and said digital computer.

53. A system according to Claim 51 in which compensation by said compensating means includes compensation for changes in characteristics in said source of flash illumination.

54. A system according to Claim 51 in which compensation by said compensating means includes compensation for changes due to aging within said system.

55. A system according to Claim 5 wherein said charge-coupled device includes a plurality of pixels disposed in rows and columns, wherein said system further includes read-out means for sequentially reading optically produced conditions of said pixels and wherein said flash coordinator comprises means for monitoring the sequential state of said read-out means to activate said source of flash illumination to effectively evenly illuminate said pixels.

56. A system according to Claim 7 wherein said video camera includes a plurality of pixels disposed in rows and columns, wherein said system further includes read-out means for sequentially reading optically produced conditions of said pixels and wherein said flash coordinator comprises means for monitoring the sequential state of said read-out means to activate said source of flash illumination to effectively evenly illuminate said pixels.

57. A system according to Claim 55 wherein said still camera includes a shutter and in which said flash coordinator is effective to momentarily open said shutter in synchronization with said source of flash illumination.

58. A system according to Claim 56 wherein said still camera includes a shutter and in which said flash coordinator is effective to momentarily open said shutter in synchronization with said source of flash illumination.

59. A system according to Claim 55 wherein said still camera includes a shutter and wherein said shutter is responsive to said flash coordinating means for opening in synchronization with said source of flash illumination and said sequential state of said read-out means whereby one full field of said charge-coupled device is exposed by said source of flash illumination.

60. A system according to Claim 56 wherein said still camera includes a shutter and wherein said shutter is responsive to said flash coordinating means for opening in synchronization with said source of flash illumination and said sequential state of said read-out means whereby one full field of said video camera is exposed by said source of flash illumination.

61. A system according to Claim 7 including scanning means for scanning consecutive fields of video produced by said video camera and wherein said flash coordinator is effective to trigger said source of flash illumination to fully and evenly expose pairs of said consecutive fields.

62. In a photographic system comprising a flash source of illumination, still image capturing means, video image capturing means and scanning means for repetitively scanning said video image capturing means, a flash illumination coordinator including:

a. means for monitoring said scanning means to identify regularly recurring benchmark points in time, said benchmark points being points at which when said flash source flashes, image capturing means in said video image capturing means is effectively illuminated evenly;

b. counting means synchronized with said benchmark points for establishing a still camera shutter opening signal timing point responsive to a request for flash signal for initiating opening of said still camera shutter so that said shutter is fully open when said flash source flashes; and

c: means responsive to said request for flash signal for causing said flash source to flash at one of said benchmark points.

63. A system according to Claim 7 including scanning means for scanning consecutive fields of video produced by said video camera and wherein said flash coordinator includes:

a. means for monitoring said scanning means to identify regularly recurrent benchmark points in time, said benchmark points being points at which when said flash source flashes, image capturing means in said video camera is effectively illuminated evenly;

b. counting means synchronized with said benchmark points for establishing a still camera shutter opening signal timing point responsive to a request for flash signal for initiating opening of said still camera shutter so that said shutter is fully open when said flash source flashes; and

c: means responsive to said request for flash signal for causing said flash source to flash at one of said benchmark points.

64. A system according to claim 63 including means for adjustably varying said timing means to match camera shutter time delay of said still camera.

65. A method of forming composite photographic images comprising:

(a) providing a characterizing background;

(b) positioning a still camera in front of said characterizing background;

(c) disposing a subject between said still camera and said characterizing background;

(d) disposing a flash illumination source and directing said flash illumination source toward said subject and said characterizing background;

(e) capturing a still image of said subject and said haracterizing background;

(f) producing a digital representation of said still image;

(g) selectinbg a digitally recorded background image; and

(h) melding said still image with said background image to form a composite.

66. The method according to Claim 65 further including a step of digitally recording a plurality of selectable background images.

67. The method according to claim 65 wherein the step of melding said still image with said background image includes a step of manipulating a digital computer to meld said images.

68. The method according to Claim 65 wherein said step of capturing said still image of said subject and said characterizing background includes a step of capturing a still image on photographic film.

69. The method according to Claim 65 wherein said step of capturing said still image of said subject and said characterizing background includes a step of capturing a still image on a charge-coupled imaging detector.

70. The method according to Claim 65 wherein said step of capturing said still image of said subject and said characterizing background includes a step of capturing a still image on photographic film and on a charge-couples imaging detector.

71. The method according to Claim 65 further including a step of recording a video image of said subject.

72. The method according to Claim 71 further including a step of momentarily reducing effective sensitivity for recording said video image of said subject.

73. The method according to Claim 65 further including a step of storing said digital representation of said still image.

74.The method according to Claim 65 wherein providing said characterizing background includes providing a process screen.

75. The method according to Claim 65 wherein providing said characterizing background includes providing a predetermined pattern thereon.

76. The method according to Claim 65 wherein providing said characterizing background includes providing a uniform color thereon.

77. The method according to Claim 65 wherein providing said characterizing background includes providing a uniform color on one section of said background and providing a predetermined pattern on another section thereof.

78. The method according to Claim 65 further including coordinating said flash illumination source with said camera.

79. The method according to Claim 78 wherein coordinating said flash illumination source includes synchronizing said source with said camera.

80. The method according to Claim 73 wherein said step of storing said digital representation of said still image is performed electronically.

81. The method according to Claim 65 further including a step of storing said digital representation of said still image both electronically and in film.

82. The method according to Claim 65 wherein the step of selecting a digitally recorded background image includes using a digital computer.

83. The method according to Claim 65 further including a step of producing an optimum set of lighting parameters for said flash illumination source.

84. The method according to Claim 82 further including a step of producing an optimum set of lighting parameters for said flash illumination source.

85. The method according to Claim 84 further including a step of automatically positioning said flash illumination source according to said optimum set of lighting parameters.

86. The method according to Claim 83 wherein said step of producing an optimum set of lighting parameters for said flash illumination source includes a step of obtaining said optimum set from said digitally recorded background image.

87. The method according to Claim 85 wherein said step of automatically positioning said flash illumination source further includes a step of setting said source of flash illumination to produce flash illumination according to said optimum set of lighting parameters.

88. The method according to Claim 87 further including a step of providing a hemispheric support and movably mounting said source of flash illumination on said hemispheric support.

89. The method according to Claim 87 wherein said step of setting said source of flash illumination includes steps of setting orientation, position, direction and lighting intensity.

90. The method according to Claim 88 wherein said step of setting said source of flash illumination includes steps of setting orientation, position, direction and lighting intensity.

91. The method according to Claim 87 wherein said step of setting said source of flash illumination to produce flash illumination according to said optimum set of lighting parameters includes hue, shadow conditioning and density.

92. The method according to Claim 89 wherein said step of setting said source of flash illumination includes steps of setting hue, shadow conditioning and density.

93. The method of Claim 90 wherein said step of setting said source of flash illumination includes steps of setting hue, shadow conditioning and density.

94. The method according to Claim 65 further including steps of providing a hemispheric support and movably mounting said flash illumination source on said hemispheric support.

95. The method according to Claim 65 further inbcluding steps of identifying emergencies and in response to said emergencies, providing immediate shut down.

96. The method according to Claim 65 further including steps of identifying routine shut-down conditions and in response to said routine shut-down conditions, providing orderly sequential shut down.

97. The method according to Claim 65 further including a step of automatically calibrating timing for said flash illumination source and said still camera.

98. The method according to Claim 71 further including a step of automatically calibrating timing for said flash illumination source, said still camera and said recording of said video image.

99. The method according to Claim 72 further including a step of automatically calibrating timing for said flash illumination source, said still camera, said recording of said video image, and said step of momentarily reducing effective sensitivity for recording said video image of said subject.

100. The method according to Claim 65 further including steps of providing data representing colors in said still image, sampling said data and automatically compensating said data to provide faithful color reproduction.

101. The method according to Claim 100 wherein the step of automatically compensating said data includes a step of compensating said data for changes in characteristics of said flash illumination source.

102. The method according to Claim 71 further including a step of providing even flash illumination for said recording of said video image of said subject.

103. The method according to Claim 102 further including a step of synchronizing operation of said still camera with said recording of said video image of said subject.

104. In a system comprising a flash source of illumination, still image capturing means having a shutter, video image capturing means and scanning means for repetitively scanning said video image capturing means, a method of flash illumination coordination including:

(a) monitoring said scanning means to identify regularly recurring benchmark points in time at which when said flash source flashes, image capturing means in said video image capturing means is effectively illuminated evenly; and

(b) measuring time with respect to said benchmarks points to identify a shutter signal activating time before a predetermined benchmark point, said shutter signal activating time being measured to occur at a point to allow time for said shutter to be fully open when said flash source flashes.

105. The method according to Claim 104 further including steps of:

(a) providing a request for flash signal; and

(b) flashing said flash source at the next predetermined benchmark point.

106. The method according to Claim 71 wherein said step of recording said video image is performed in a video camera, further including steps of:

(a) scanning said video camera to identify regularly recurrent benchmark points in time at which if said flash source flashes, image capturing means in said video image capturing means is effectively illuminated evenly; and

(b) measuring time with respect to said benchmarks points to identify a still camera shutter signal activating time before a next benchmark point, said shutter signal activating time being measured to occur at a point to allow time for said shutter to be fully open when said flash source flashes.

107. The method according to Claim 106 in which said step of measuring time includes a step of varying said time to conform to shutter opening time of said still camera.

108. The method according to Claim 106 further including steps of:

(a) producing a request for flash signal; and

(b) causing said flash source to flash at one of said benchmark points.

109. A method of forming composite photographic images comprising:

(a) providing a characterizing background;

(b) positioning a still camera in front of said characterizing background;

(c) disaposing a subject between said still camera and said characterizing background;

(d) disposing a flash illumination source and directing said flash illumination source toward said subject and said characterizing background;

(e) providing a video camera;

(f) scanning said video camera to identify regularly recurring benchmark points in time at which if said flash source flashes, image capturing means in said video image capturing means is effectively illuminated evenly;

(g) producing a request for flash signal;

(h) causing said flash source to flash at one of said benchmark points;

(i) measuring time with respect to said benchmarks points to identify a still camera shutter signal activating time before a next benchmark point, said shutter signal activating time being measured to occur at a point to allow time for the shutter of said still camera to be fully open when said flash source flashes;

(j) recording a video image of said subject by said video camera;

(k) capturing a still image of said subject and said characterizing background;

(l) producing a difital representation of said still image;

(m) selecting a digitally recorded background image; and

(n) melding said still image with said background image to form a composite.

110. The method according to Claim 71 wherein said step of disposing said subject includes a step of posing said subject.

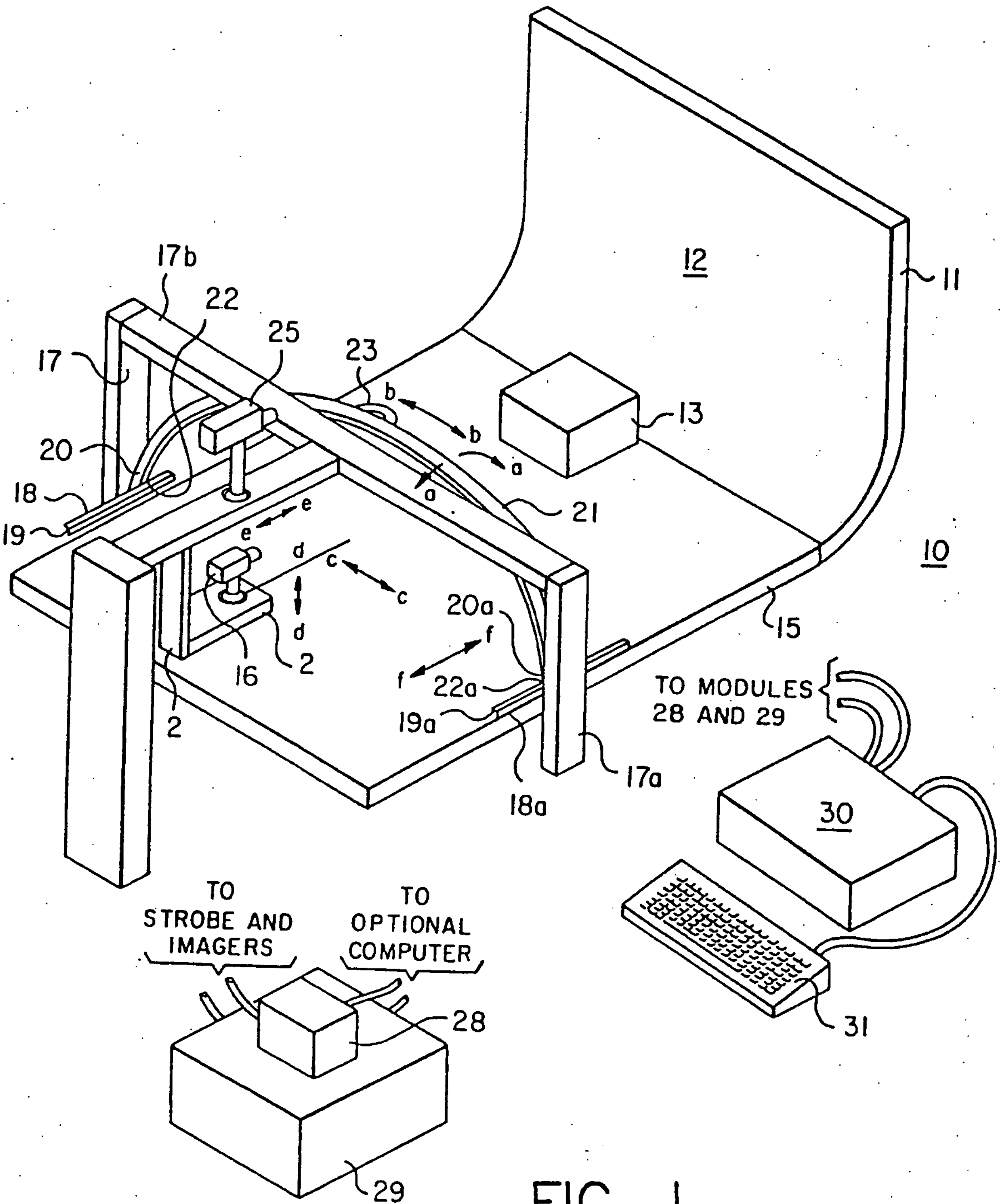

17b
22
25
23
17
20
18
19
b
b
a
a
e
e
d
c
c
d
d
16
2
2
2
12
11
13
21
10
15
20a
f
f
22a
19a
18a
17a
TO MODULES 28 AND 29
30
31
TO STROBE AND IMAGERS
TO OPTIONAL COMPUTER
28
29

FIG. 1

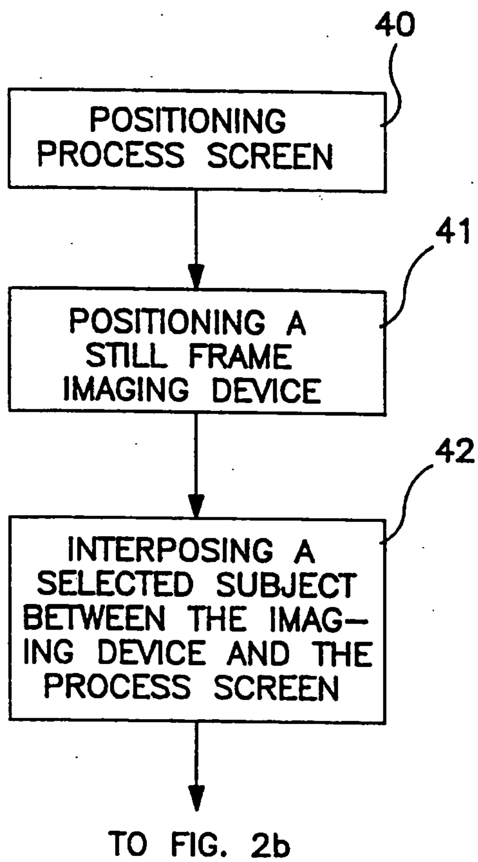

40
POSITIONING PROCESS SCREEN
41
POSITIONING A STILL FRAME IMAGING DEVICE
42
INTERPOSING A SELECTED SUBJECT BETWEEN THE IMAG- ING DEVICE AND THE PROCESS SCREEN
TO FIG. 2b

FIG. 2a

FROM FIG. 2a

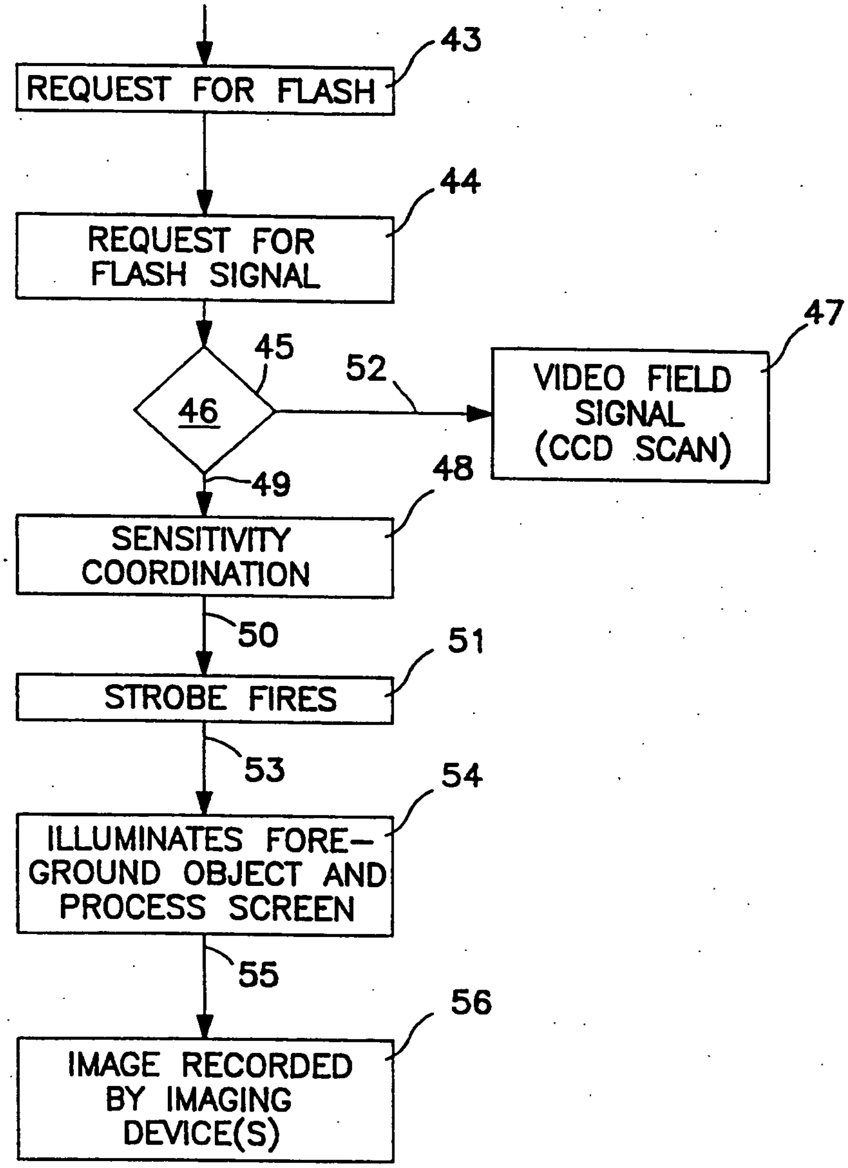


FIG. 2b

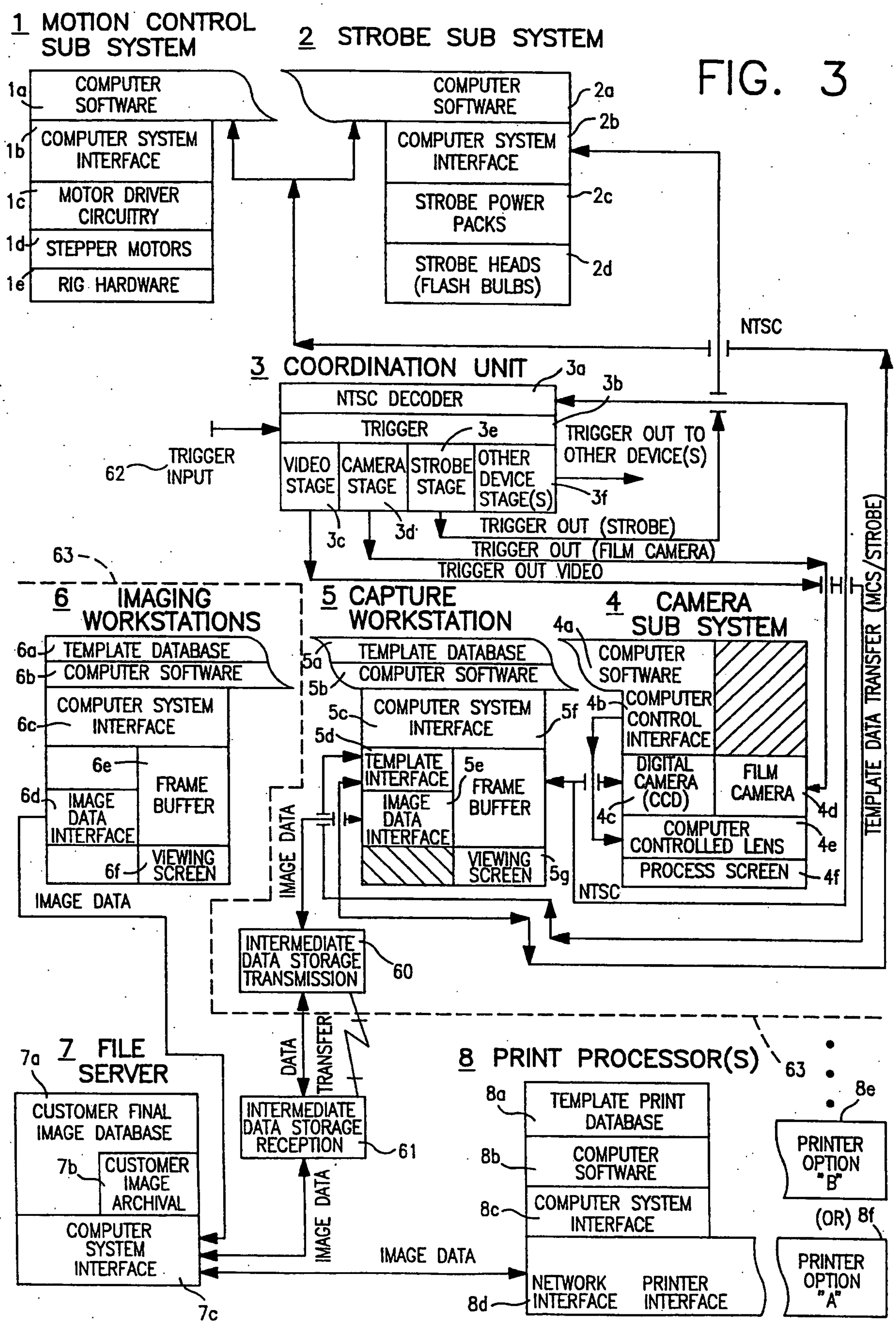
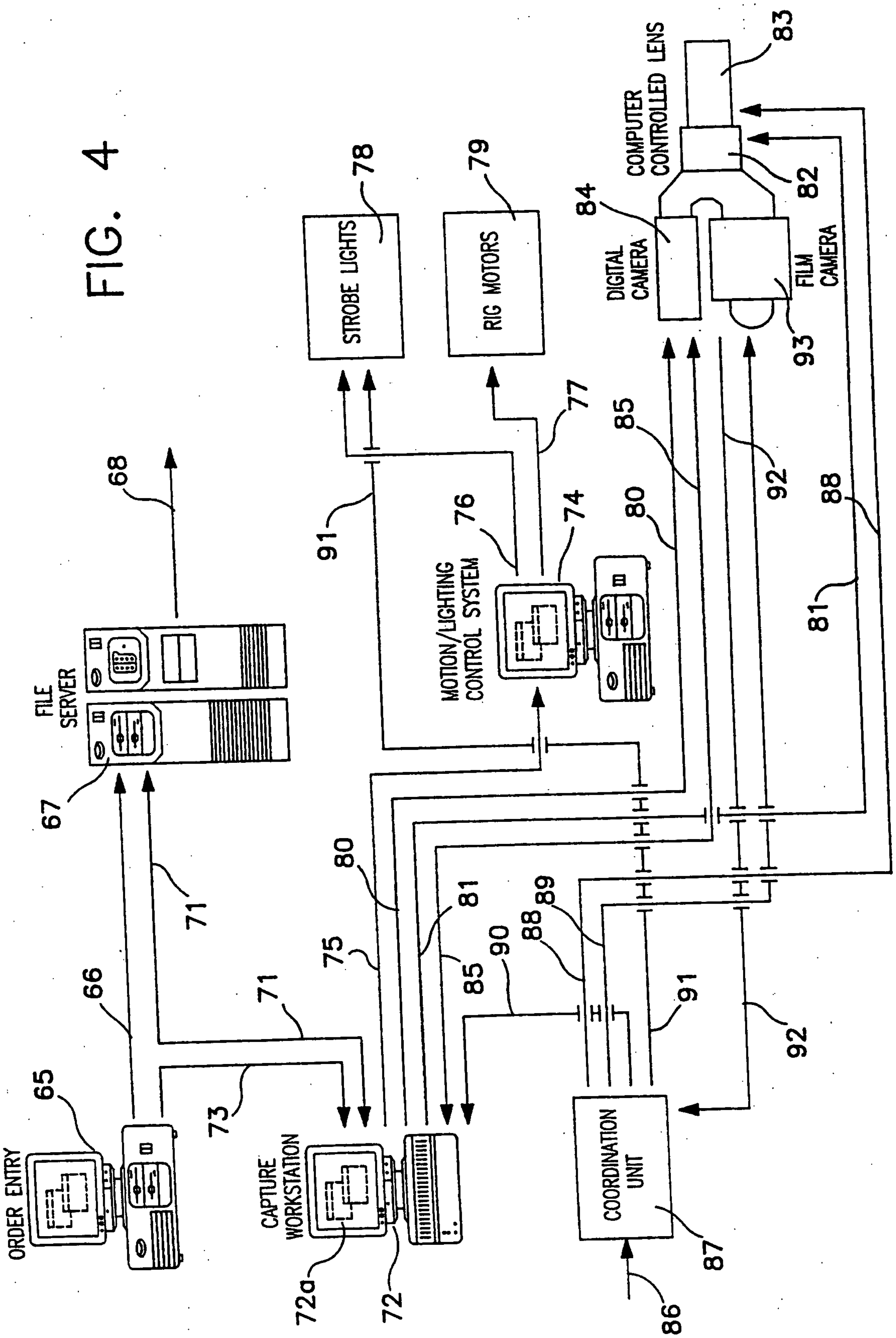

1 MOTION CONTROL SUB SYSTEM
1a COMPUTER SOFTWARE
1b COMPUTER SYSTEM INTERFACE
1c MOTOR DRIVER CIRCUITRY
1d STEPPER MOTORS
1e RIG HARDWARE
2 STROBE SUB SYSTEM
2a COMPUTER SOFTWARE
2b COMPUTER SYSTEM INTERFACE
2c STROBE POWER PACKS
2d STROBE HEADS (FLASH BULBS)
NTSC
3 COORDINATION UNIT
3a NTSC DECODER
3b TRIGGER
3e
TRIGGER OUT TO OTHER DEVICE(S)
62 TRIGGER INPUT
VIDEO STAGE
CAMERA STAGE
STROBE STAGE
OTHER DEVICE STAGE(S)
3c
3d
3f
TRIGGER OUT (STROBE)
TRIGGER OUT (FILM CAMERA)
TRIGGER OUT VIDEO
TEMPLATE DATA TRANSFER (MCS/STROBE)
63
6 IMAGING WORKSTATIONS
6a TEMPLATE DATABASE
6b COMPUTER SOFTWARE
6c COMPUTER SYSTEM INTERFACE
6e FRAME BUFFER
6d IMAGE DATA INTERFACE
6f VIEWING SCREEN
IMAGE DATA
5 CAPTURE WORKSTATION
5a TEMPLATE DATABASE
5b COMPUTER SOFTWARE
5c COMPUTER SYSTEM INTERFACE
5f
5d TEMPLATE INTERFACE
IMAGE DATA INTERFACE
5e FRAME BUFFER
VIEWING SCREEN
5g
4 CAMERA SUB SYSTEM
4a COMPUTER SOFTWARE
4b COMPUTER CONTROL INTERFACE
DIGITAL CAMERA (CCD)
4c
FILM CAMERA
4d
COMPUTER CONTROLLED LENS
4e
PROCESS SCREEN
4f
NTSC
IMAGE DATA
INTERMEDIATE DATA STORAGE TRANSMISSION
60
DATA TRANSFER
INTERMEDIATE DATA STORAGE RECEPTION
61
IMAGE DATA
7 FILE SERVER
7a CUSTOMER FINAL IMAGE DATABASE
7b CUSTOMER IMAGE ARCHIVAL
COMPUTER SYSTEM INTERFACE
7c
IMAGE DATA
8 PRINT PROCESSOR(S)
63
8a TEMPLATE PRINT DATABASE
8b COMPUTER SOFTWARE
8c COMPUTER SYSTEM INTERFACE
8d NETWORK INTERFACE
PRINTER INTERFACE
8e
PRINTER OPTION "B"
(OR) 8f
PRINTER OPTION "A"

FIG. 3

FIG. 4


ORDER ENTRY
65
66
73
71
CAPTURE WORKSTATION
72a
72
FILE SERVER
67
68
75
80
81
85
90
88
89
91
92
COORDINATION UNIT
87
86
MOTION/LIGHTING CONTROL SYSTEM
76
74
STROBE LIGHTS
78
RIG MOTORS
79
77
DIGITAL CAMERA
84
FILM CAMERA
93
COMPUTER CONTROLLED LENS
82
83

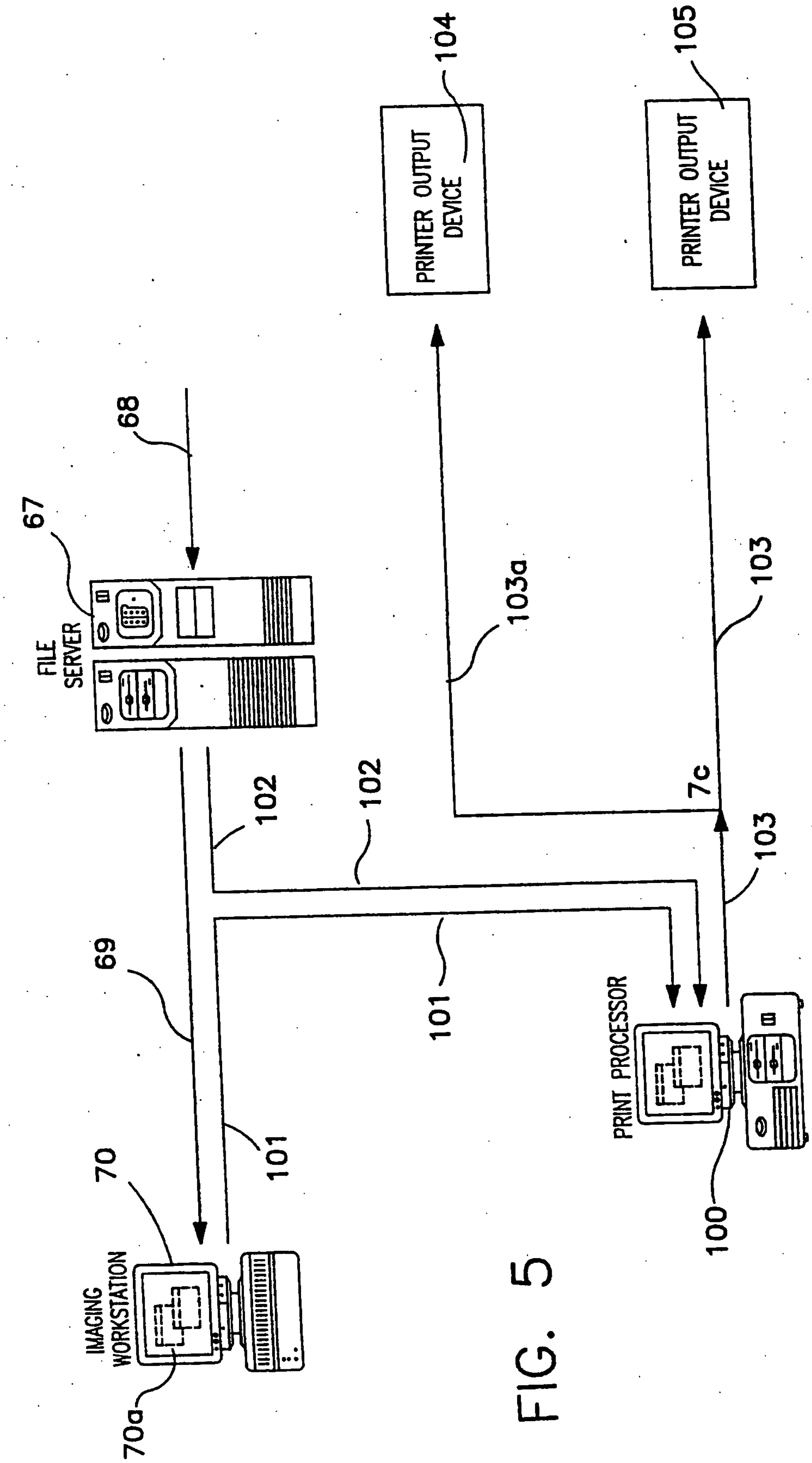

PRINTER OUTPUT DEVICE
104
PRINTER OUTPUT DEVICE
105
68
67
FILE SERVER
103a
103
7c
102
102
103
69
101
101
PRINT PROCESSOR
70
100
IMAGING WORKSTATION
70a

FIG. 5

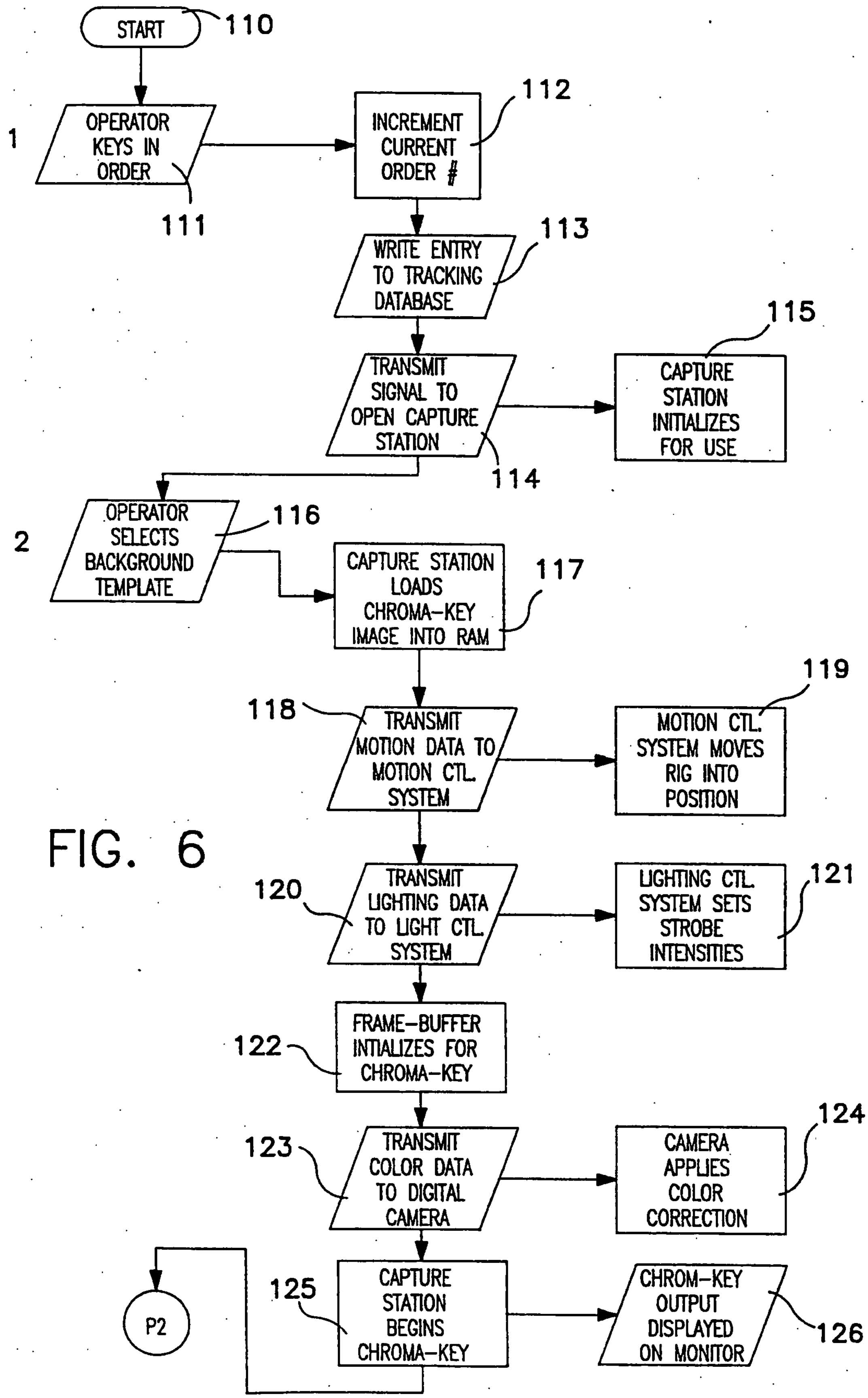

START
110
1
OPERATOR KEYS IN ORDER
111
INCREMENT CURRENT ORDER #
112
WRITE ENTRY TO TRACKING DATABASE
113
TRANSMIT SIGNAL TO OPEN CAPTURE STATION
114
CAPTURE STATION INITIALIZES FOR USE
115
2
OPERATOR SELECTS BACKGROUND TEMPLATE
116
CAPTURE STATION LOADS CHROMA-KEY IMAGE INTO RAM
117
118
TRANSMIT MOTION DATA TO MOTION CTL. SYSTEM
MOTION CTL. SYSTEM MOVES RIG INTO POSITION
119
120
TRANSMIT LIGHTING DATA TO LIGHT CTL. SYSTEM
LIGHTING CTL. SYSTEM SETS STROBE INTENSITIES
121
122
FRAME-BUFFER INTIALIZES FOR CHROMA-KEY
123
TRANSMIT COLOR DATA TO DIGITAL CAMERA
CAMERA APPLIES COLOR CORRECTION
124
P2
125
CAPTURE STATION BEGINS CHROMA-KEY
CHROM-KEY OUTPUT DISPLAYED ON MONITOR
126

FIG. 6

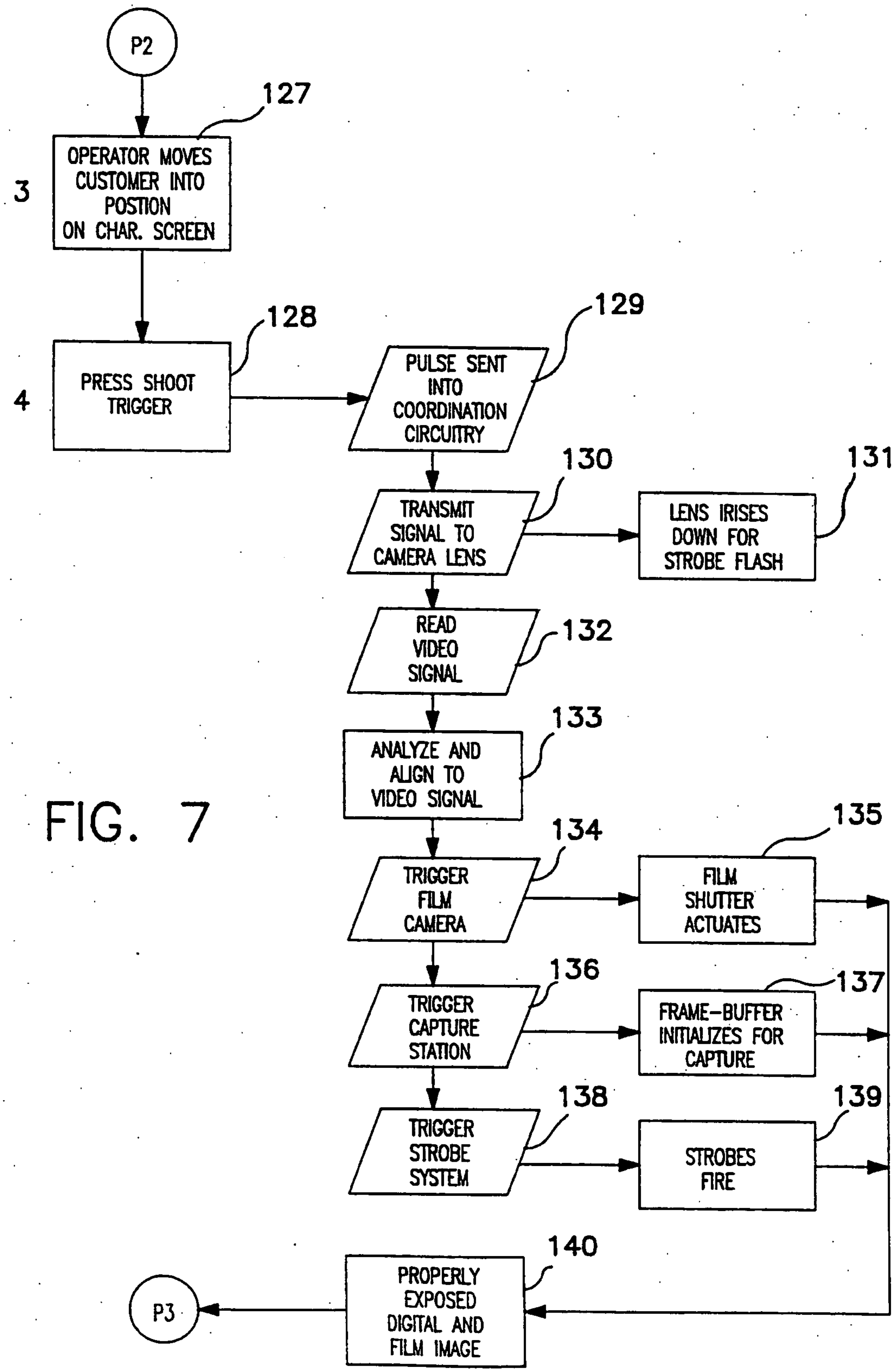
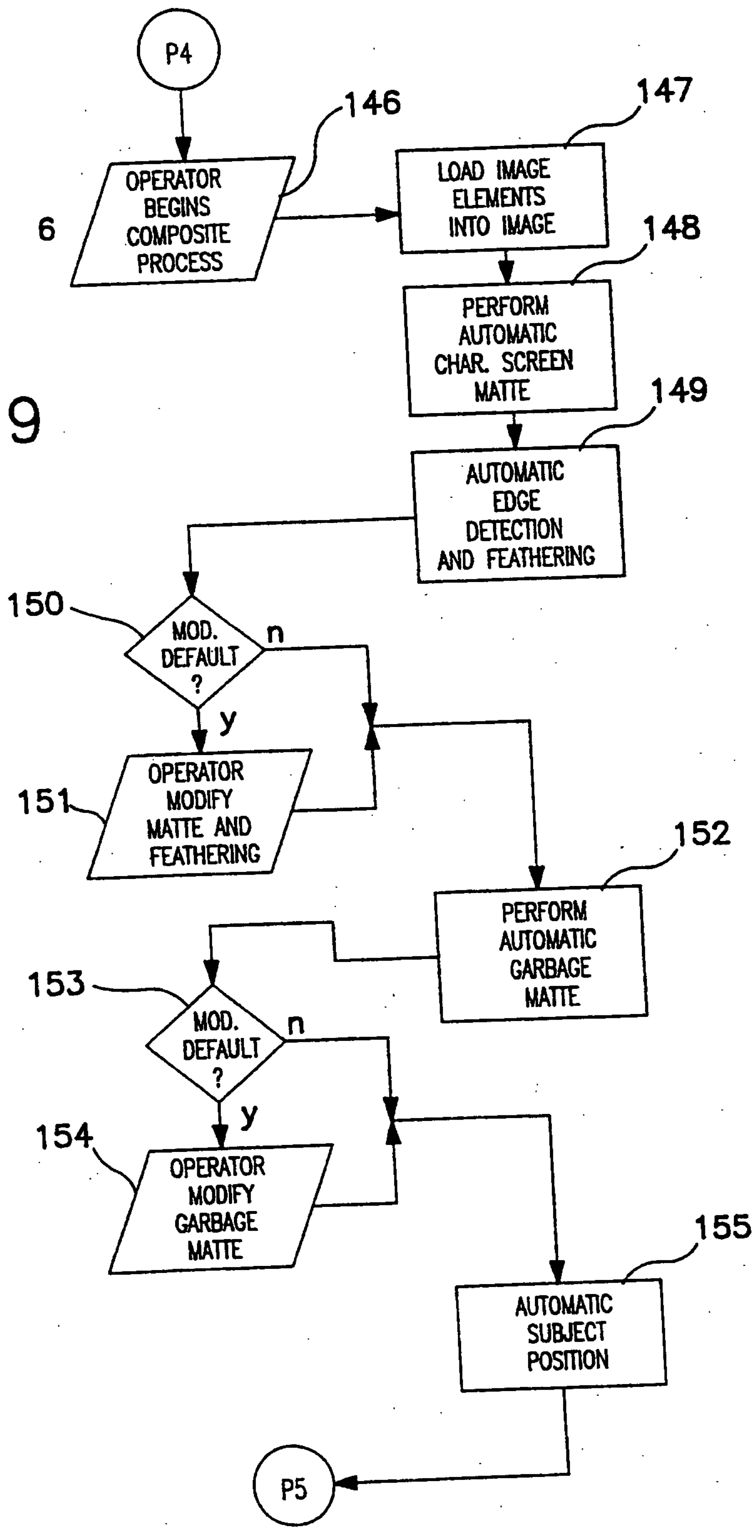

P2
127
OPERATOR MOVES CUSTOMER INTO POSTION ON CHAR. SCREEN
3
128
PRESS SHOOT TRIGGER
4
129
PULSE SENT INTO COORDINATION CIRCUITRY
130
TRANSMIT SIGNAL TO CAMERA LENS
131
LENS IRISES DOWN FOR STROBE FLASH
132
READ VIDEO SIGNAL
133
ANALYZE AND ALIGN TO VIDEO SIGNAL
134
TRIGGER FILM CAMERA
135
FILM SHUTTER ACTUATES
136
TRIGGER CAPTURE STATION
137
FRAME-BUFFER INITIALIZES FOR CAPTURE
138
TRIGGER STROBE SYSTEM
139
STROBES FIRE
140
PROPERLY EXPOSED DIGITAL AND FILM IMAGE
P3

FIG. 7



P4
OPERATOR BEGINS COMPOSITE PROCESS
6
146
LOAD IMAGE ELEMENTS INTO IMAGE
147
PERFORM AUTOMATIC CHAR. SCREEN MATTE
148
AUTOMATIC EDGE DETECTION AND FEATHERING
149
150
MOD. DEFAULT ?
n
y
OPERATOR MODIFY MATTE AND FEATHERING
151
PERFORM AUTOMATIC GARBAGE MATTE
152
153
MOD. DEFAULT ?
n
y
OPERATOR MODIFY GARBAGE MATTE
154
AUTOMATIC SUBJECT POSITION
155
P5

FIG. 9

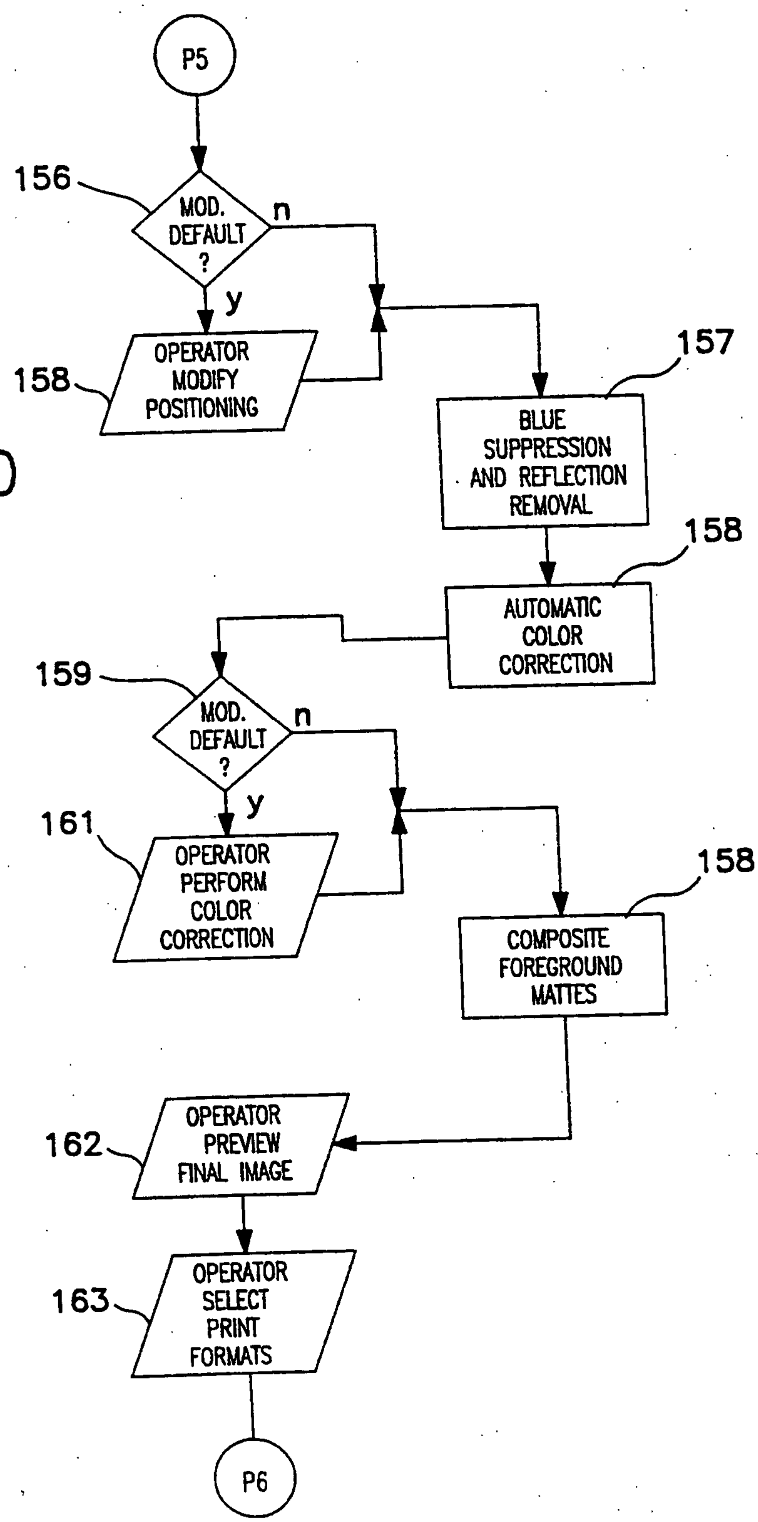

P5
156
MOD. DEFAULT ?
n
y
158
OPERATOR MODIFY POSITIONING
157
BLUE SUPPRESSION AND REFLECTION REMOVAL
158
AUTOMATIC COLOR CORRECTION
159
MOD. DEFAULT ?
n
y
161
OPERATOR PERFORM COLOR CORRECTION
158
COMPOSITE FOREGROUND MATTES
162
OPERATOR PREVIEW FINAL IMAGE
163
OPERATOR SELECT PRINT FORMATS
P6

FIG. 10

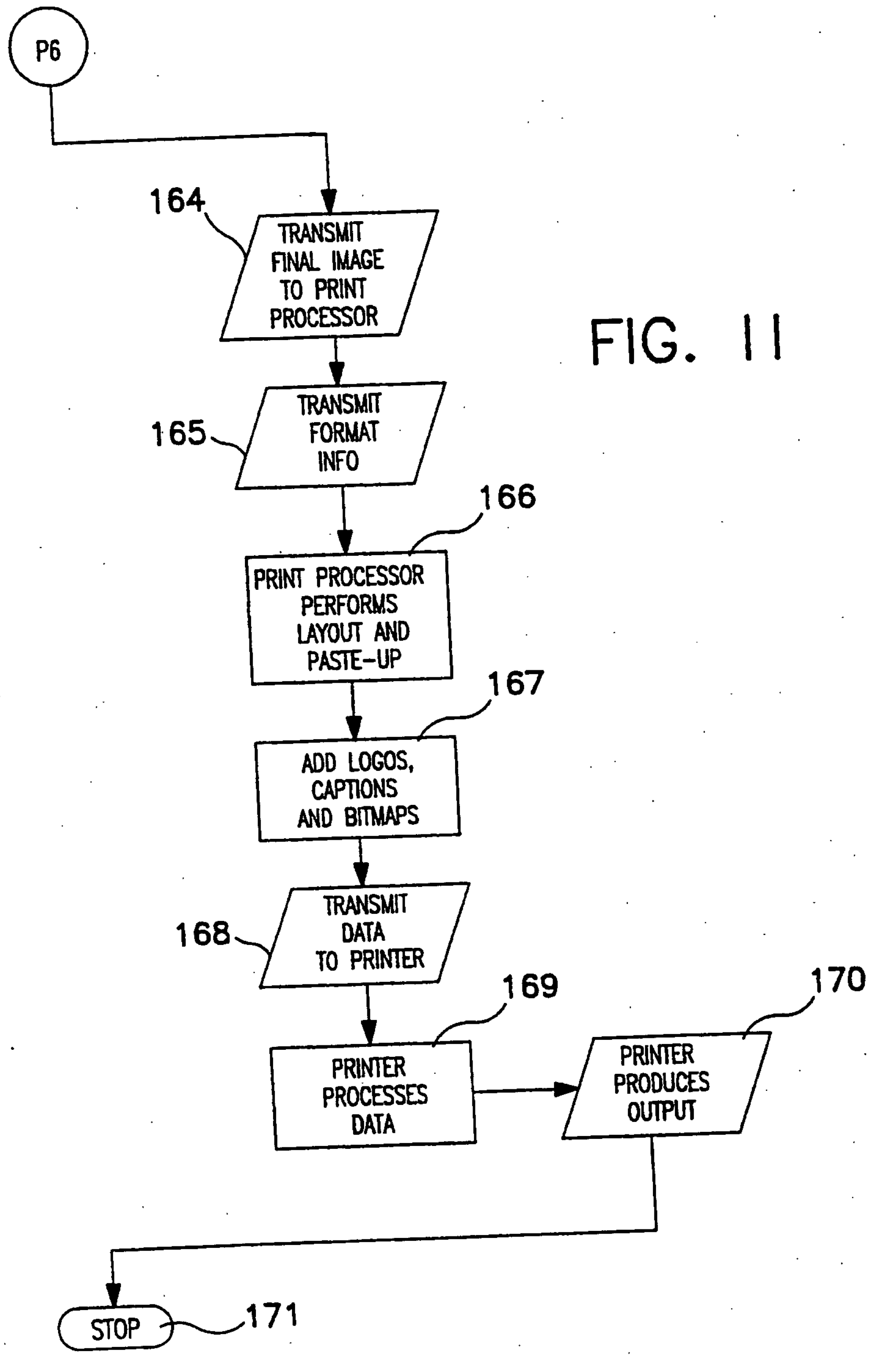

P6
164
TRANSMIT FINAL IMAGE TO PRINT PROCESSOR
165
TRANSMIT FORMAT INFO
166
PRINT PROCESSOR PERFORMS LAYOUT AND PASTE-UP
167
ADD LOGOS, CAPTIONS AND BITMAPS
168
TRANSMIT DATA TO PRINTER
169
PRINTER PROCESSES DATA
170
PRINTER PRODUCES OUTPUT
STOP
171

FIG. 11

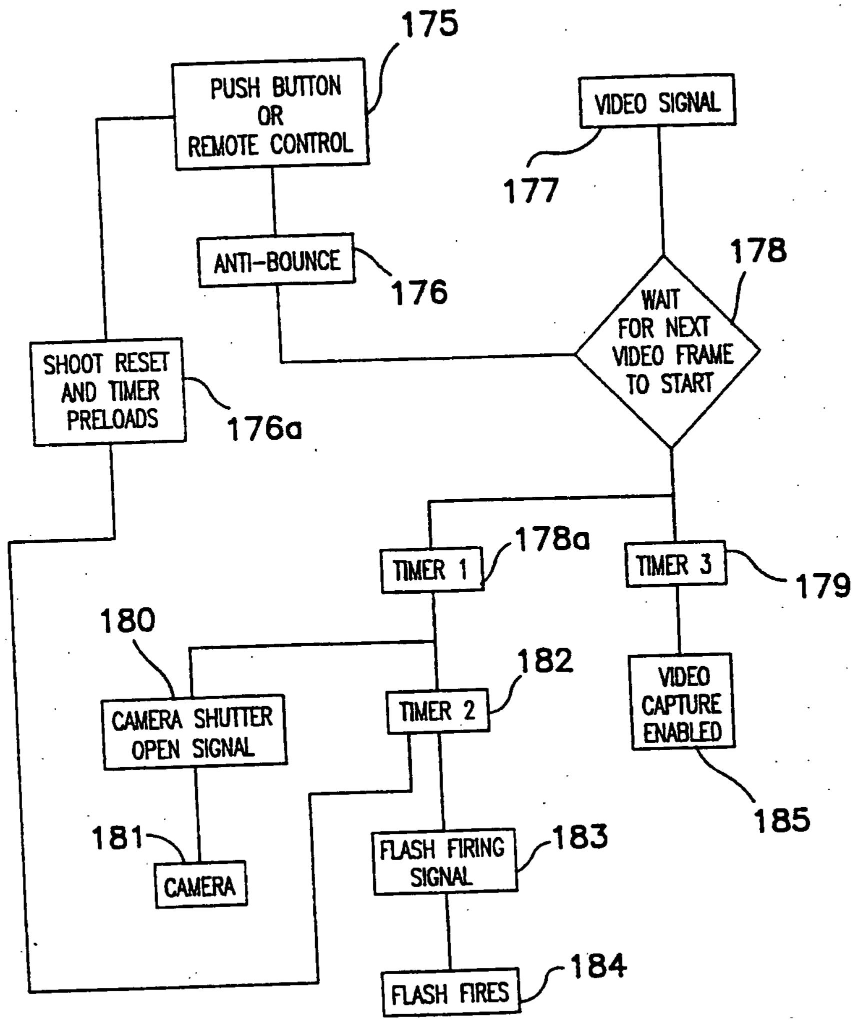

175
PUSH BUTTON OR REMOTE CONTROL
VIDEO SIGNAL
177
ANTI-BOUNCE
176
178
WAIT FOR NEXT VIDEO FRAME TO START
SHOOT RESET AND TIMER PRELOADS
176a
TIMER 1
178a
TIMER 3
179
180
182
VIDEO CAPTURE ENABLED
CAMERA SHUTTER OPEN SIGNAL
TIMER 2
185
181
CAMERA
FLASH FIRING SIGNAL
183
FLASH FIRES
184

FIG. 12

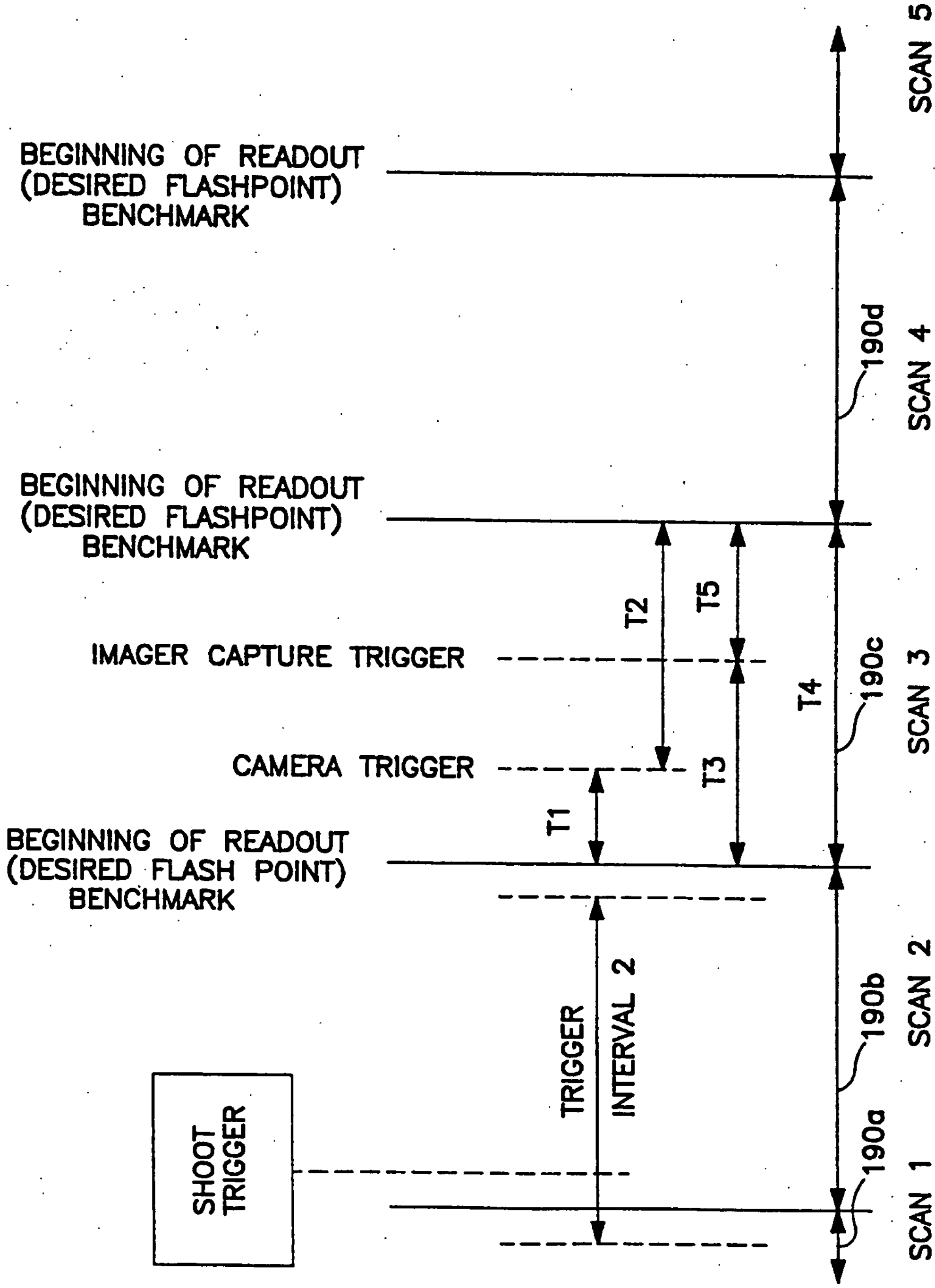

BEGINNING OF READOUT
(DESIRED FLASHPOINT)
BENCHMARK
BEGINNING OF READOUT
(DESIRED FLASHPOINT)
BENCHMARK
IMAGER CAPTURE TRIGGER
CAMERA TRIGGER
BEGINNING OF READOUT
(DESIRED FLASH POINT)
BENCHMARK
SHOOT TRIGGER
TRIGGER INTERVAL 2
T1
T2
T3
T4
T5
190a
190b
190c
190d
SCAN 1
SCAN 2
SCAN 3
SCAN 4
SCAN 5

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/06494

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 5/222, 5/225.
US CL : 348/ 47,48,49,220,722; 354/ 413,290,291,292,293.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/ 47,48,49,220,722, 223,552,649; 354/ 413,290,291,292,293,68,71.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, search terms: camera, hue, shadow, density, computer or processor. search terms: composite, still camera, video camera, flash, background image.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,805,037 (NOBLE ET AL.) 14 Feb 1989, col. 3, line 65 to col. 8, line 68	1-110
Y	US, A, 5,008,697 (NOBLE) 16 April 1991, col. 2, line 60 to col. 5, line 21.	1-110
Y	US, A, 5,006,871 (NOBLE) 09 April 1991, col. 3, line 1 to col. 5, line 55.	1-110
Y	US, A, 4,169,666 (SLATER ET AL.) 02 October 1979, col. 3, line 46 to col. 6, line 35.	1-110
Y	US, A, 4,738,526 (LARISH) 19 April 1988, col. 2, lines 40-41.	37,38.
Y	US, A, 4,788,565 (MASUDA ET AL.) 29 November 1988, col. 3, line 56 to col. 6, line 41.	1-110

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 JULY 1995	04 AUG 1995

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer BIPIN SHALWALA Telephone No. (703) 305-4938

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,829,383 (HARASE ET AL.) 09 May 1989, col. 3, line 1, to col. 7, line 62. Fig. 4A, item 152, white balance sensor	22-27, 31-3 3.
Y	US, A, 4,366,501 (TSUNEKAWA ET AL.) 28 December 1982, all document.	1-110
Y	US, A, 4,417,791 (EARLAND ET AL.) 29 November 1983, col. 6, line 35 to col. 10, line 68.	1-110
Y	US, A, 4,602,286 (KELLAR ET AL.) 22 July 1986, col. 2, line 4, to col. 4, line 45	1-110
Y	US, A, 5,117,283 (KROOS ET AL.) 26 May 1992, col. 4, line 25 to col. 11, line 20.	1-110
Y	US, A, 4,667,221 (CAWLEY ET AL.) 19 May 1987, all article.	1-110
Y	US, A, 4,825,290 (IIDA ET AL.) 25 April 1989, col. 2, line 45 to col. 5, line 36.	1-110
Y	US, A, 4,089,017 (BULDINI) 09 May 1978 , col. 26, lines 1-2.	35-36.
Y	US, A, 4,468,693 (FUJITA ET AL.) 28 August 1984, col. 12, line 63 to col. 13 line 11, col. 8, lines 19-39.	31-33, 91-93.